AGRICULTURAL
Technical Systems and Mechanics
Study Guide

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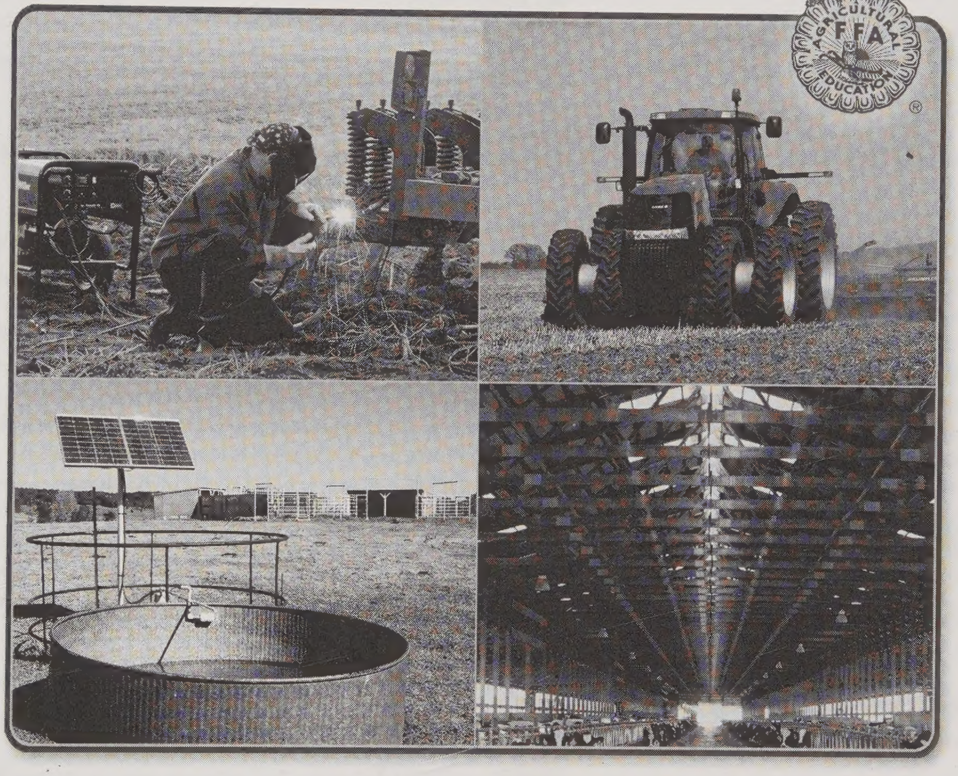

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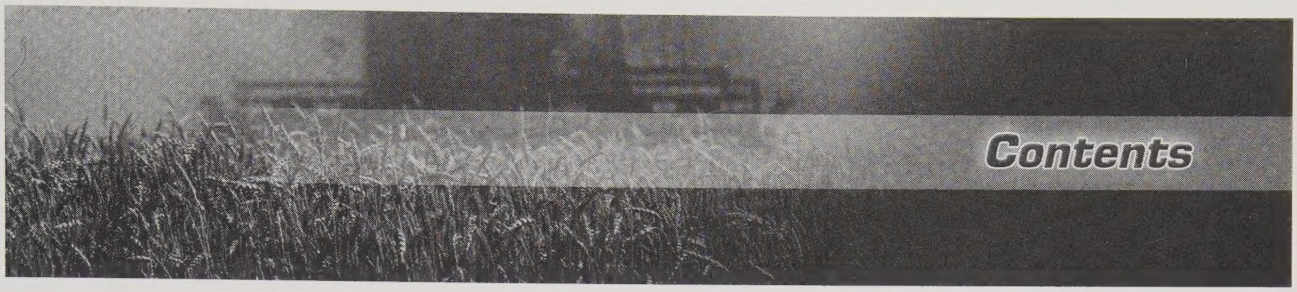

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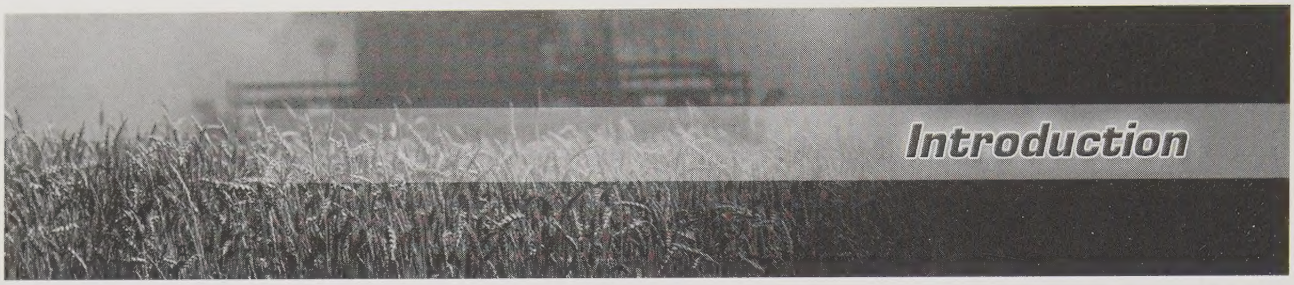

Introduction

The *Agricultural Technical Systems and Mechanics Study Guide* includes review questions and activities that reinforce and apply the content presented in each chapter of the textbook. The review questions include true-false, multiple choice, completion, short answer, and identification formats that reinforce comprehension. Activities include scenarios and industry applications related to the concepts presented in each chapter the textbook.

Agricultural Technical Systems and Mechanics addresses the knowledge and skills included in the Power, Structural and Technical Systems (PST) pathway as identified by the National AFNR Career Cluster Content Standards. These standards guide curriculum development in specific areas within the agricultural industry and ensure competency upon program completion. In addition, the knowledge and skills acquired can be used to prepare for participation in the Agricultural Technology and Mechanical Systems career development event (CDE).

The National Council for Agricultural Education granted permission for the reproduction of the excerpts from the National AFNR Career Cluster Content Standards addressed within *Agricultural Technical Systems and Mechanics*. The excerpts are listed in the front matter of the textbook and in the Instructional Plans section of the *Agricultural Technical Systems and Mechanics Instructor's Resource Guide.*

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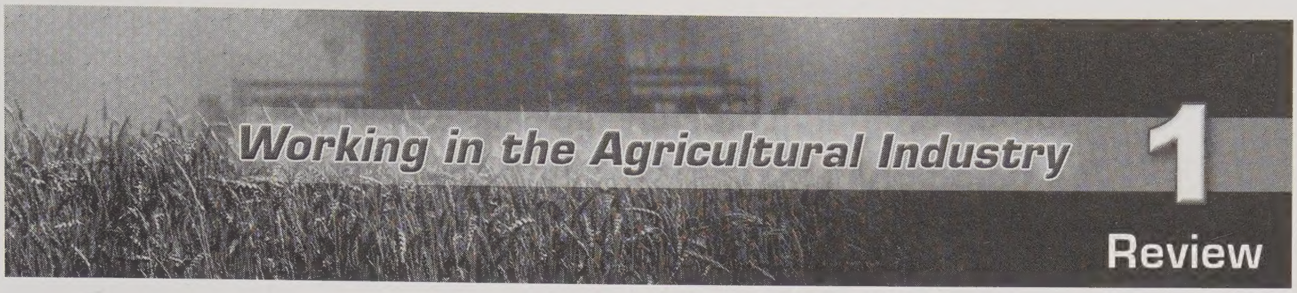


Working in the Agricultural Industry

1

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** Agricultural environments can be both rural and urban.

T F **2.** An agricultural mechanic must be able to install, maintain, and operate plumbing, irrigation, and electrical systems.

T F **3.** Material selection is not an important part of component design and repair.

T F **4.** Common agricultural structures include pole barns, out buildings, poultry barns, and greenhouses.

T F **5.** Irrigation systems are never used in geographic areas with low annual rainfall or during times of drought.

T F **6.** Cutting, welding, and joining are important processes used in agriculture to fabricate and repair structures and agricultural equipment.

T F **7.** Most agricultural machinery is powered with internal combustion engines that require gasoline or diesel fuel.

T F **8.** Because of the ongoing depletion of fossil fuel resources, equipment operation through sustainable energy resources is being developed to help prepare agricultural operations for the future.

T F **9.** An agricultural mechanic cannot provide technical service for agricultural power equipment manufacturers.

T F **10.** Student networking provides students with opportunities for personal growth, career success, and leadership development.

T F **11.** Agricultural mechanics rarely need to communicate through electronic media.

T F **12.** The Collegiate FFA is the arm of the National FFA that implements services for postsecondary and collegiate students.

T F **13.** Agricultural mechanics use diesel, combustion, electrical, steam, hydraulic, and mechanical system principles to maintain tractors and hauling, planting, cutting, and harvesting equipment.

T F **14.** Agricultural mechanics must be able to access information, prioritize tasks, and apply knowledge in order to maintain and repair mechanical equipment in the agricultural workplace.

T F **15.** Key technical skills for agricultural mechanics include using hand tools and equipment to install, position, move, and manipulate materials.

T F **16.** Written instructions must accurately convey information.

T F **17.** Only hard-copy documents are required to go through a proofreading process because proper grammar and spelling are not critical with electronic communications.

T F **18.** The first step for a potential job applicant is to create a résumé and compile a portfolio of skill-based accomplishments, such as projects that have been completed by the applicant and work performed in agricultural environments.

[✓ T] F **19.** An effective résumé includes a career objective and lists the education and training, work experience, and accomplishments of the applicant.

T F **20.** Job search tools such as networking, online resources, and print resources all present opportunities that could lead to a career in the agriculture industry.

T [✓ F] **21.** Online research is the most common means of finding employment.

T [✓ F] **22.** A typical employment application never requires the applicant to list basic information such as name, address, relevant work experience, educational background, position desired, and availability.

T [✓ F] **23.** Interviews should only be face-to-face.

[✓ T] F **24.** Researching the hiring company prior to an interview can help applicants interview with confidence.

[✓ T] F **25.** It is important to always react professionally, regardless of whether or not a job is offered and accepted.

Multiple Choice

______________ **1.** Agriculture commodities include ____ and countless plant and animal products.
- A. food
- B. fiber
- C. wood products
- D. all of the above

______________ **2.** Most agricultural surveying work is typically performed by a(n) ____.
- A. architect
- B. authority having jurisdiction
- C. certified land surveyor
- D. agricultural equipment operator

________________ **3.** Typical agricultural applications for ___ include structural foundations, flooring slabs, retaining walls, livestock housing, and roadway paving.
A. concrete and masonry
B. electrical systems
C. plumbing irrigation
D. welding processes

________________ **4.** Specialized agricultural structures include ___ structures.
A. aquaculture
B. outbuilding
C. prefabricated
D. none of the above

________________ **5.** An understanding of ___ is required prior to working with electrical equipment.
A. current levels
B. safety practices
C. voltage levels
D. all of the above

________________ **6.** ___ typically perform most of the welding and metalworking required on a farm.
A. Agricultural mechanics
B. Certified welders
C. Technical service representatives employed by original equipment manufacturers (OEMs)
D. none of the above

________________ **7.** Networking for open positions within a particular industry or field requires talking to ___.
A. instructors from schools attended
B. representatives from relevant companies
C. classmates and acquaintances
D. all of the above

________________ **8.** The ___ is the official adult student organization for agricultural education as recognized by the U.S. Department of Education.
A. Future Farmers of America (FFA)
B. American Society of Agricultural and Biological Engineers (ASABE)
C. National Young Farmer Educational Association (NYFEA)
D. National Agriculture, Food, and Natural Resources (AFNR) Career Cluster

________________ **9.** Agricultural mechanics depend on basic ___ and time management skills to be successful on the job.
A. communication
B. math
C. teamwork
D. all of the above

______________ **10.** ___ is required in order to reference technical information, learn about changes in equipment and technology, and gain the knowledge necessary to speak intelligently.
A. Science
B. Reading
C. Geography
D. Math

______________ **11.** ___ management involves the effective use of one's own time as well as planning for the efficient use of time for others.
A. Time
B. Project
C. Marketing
D. none of the above

______________ **12.** A(n) ___ should be brief, factual, and accurate and outline the work experience, skills, and accomplishments that relate to the position being sought.
A. résumé
B. career objective
C. portfolio
D. application

______________ **13.** Along with a résumé, many employers also require ___ professional reference(s).
A. one
B. one to three
C. two to five
D. five to seven

______________ **14.** A(n) ___ is a collection of items that reflect the knowledge, skills, and accomplishments of an individual.
A. résumé
B. portfolio
C. career objective
D. application

______________ **15.** When a job is offered, the applicant may ___.
A. accept the position
B. decline the position
C. ask for time to consider the offer
D. all of the above

Completion

______________ **1.** ___ is the industry that encompasses the production of agricultural commodities.

______________ **2.** Agricultural mechanics must wear ___ and know when to take a tool out of service and replace it with a new tool.

______________ **3.** ___ used in agricultural applications include nails, screws, bolts, rivets, staples, pins, or keys to hold structural materials and components together.

______________ **4.** ___ requires the ability to read drawings, plans, prints, and project specifications.

______________ **5.** ___ is commonly used to contain livestock, horses, and poultry or to protect farm animals from predators.

______________ **6.** ___ processes used include oxyfuel, arc, and resistance.

______________ **7.** A(n) ___ is a group of similar occupations and industries developed by the U.S. Department of Education as a method to organize career planning.

______________ **8.** Founded in 1980, the ___ is available to students in agriculture, agribusiness, and natural resources programs in over 500 collegiate institutions.

______________ **9.** The ___ systems pathway relates to the operation and maintenance of components, structures, and equipment used by the agriculture industry.

______________ **10.** A vital career option in the PST career pathway is ___.

______________ **11.** The ___ effectively prepares students for the work environment by challenging them to apply their knowledge and skills to a range of interrelated technologies within five systems.

______________ **12.** The Agricultural Mechanics CDE for ___ systems applies knowledge and skills to mechanical power, electrical power, chemical power, wind power, and solar power systems.

______________ **13.** ___ is used every day by agricultural mechanics to understand the relationships of numbers and how they can be used to establish patterns, create estimates, measure materials, calculate costs, calculate profitability, determine spatial relationships, predict probability, and review financial data.

______________ **14.** Earth science and ___ science explain how natural resources can be used effectively and not wastefully.

______________ **15.** A(n) ___ is a concise document listing the education, professional experience, and related interests of a job applicant.

______________ **16.** A(n) ___ is a direct statement expressing the type of employment goal being sought.

______________ **17.** A(n) ___ is a collection of items that reflect the knowledge, skills, and accomplishments of an individual.

______________ **18.** ___ is a means of using personal connections, such as contacts through professional organizations, colleagues, instructors, friends, and acquaintances, to locate possible employment opportunities.

______________ **19.** ___ are written for and by members of the agricultural industry and provide valuable information about the industry.

______________ **20.** A(n) ___ is an opportunity to determine if the experience, skills, and background of the applicant match the requirements of the position.

Short Answer

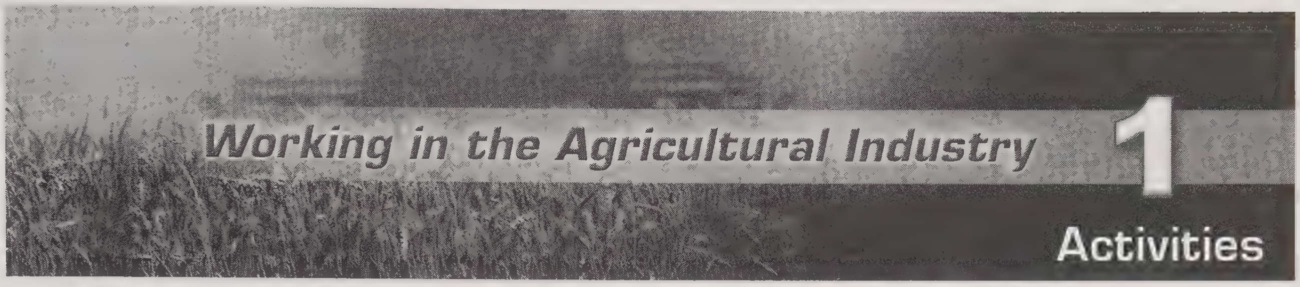
1. List and describe the student leadership organizations developed for agricultural students.

2. What is the main focus of the power, structural, and technical (PST) system?

3. Explain the difference between a résumé and a portfolio.

4. What job search tools are available to job candidates?

5. List three guidelines that can help applicants interview with confidence.



Working in the Agricultural Industry

1

Activities

Name ______________________________ **Date** ____________________

Activity 1-1: Sample Résumé Development

1. Develop a sample résumé that lists career objectives, education, work experience, and relevant accomplishments.

Safety and Health

2

Review

Name ______________________________ Date ____________________

True-False

T F **1.** A government agency is a federal, state, or local government organization or department that establishes rules and regulations related to safety, health, and equipment installation and operation.

T F **2.** A standards organization is an organization affiliated with relevant governmental organizations.

T F **3.** The American Society of Testing and Materials (ASTM International) is a professional and technical organization of members interested in engineering knowledge and technology in food and agriculture, associated industries, and related resources.

T F **4.** A chemical hazard is a solid, liquid, gas, mist, dust, and/or vapor that is toxic when inhaled, absorbed, or ingested.

T F **5.** Common tasks requiring no specialized personal protective equipment (PPE) include cleaning parts with solvent, welding, and working with hot or sharp engine components and equipment.

T F **6.** Back injuries are one of the most common injuries resulting in lost time in the workplace.

T F **7.** Class B fires include flammable and combustible liquids such as gasoline, oil, grease, and paint.

T F **8.** A combustible liquid is a liquid that has a flash point at or below 100°F (38°C).

T F **9.** The most common hydrocarbon-based materials used in agricultural applications are gasoline, diesel fuel, and kerosene.

T F **10.** A hazardous material is a material capable of posing a risk to health, safety, or property.

T F **11.** Lead is a mineral that has long, silky fibers in a crystal formation and was a component of many building materials including fireproofing, pipe insulation, siding, and tile installed until the late 1980s.

T F **12.** A carcinogen is a specific agent (bacterium or virus) of a disease in the blood.

T F **13.** According to the National Safety Council, over 1000 people are killed by electrical shock in the United States each year.

T F **14.** Bonding is the connection of all exposed non-current-carrying metal parts to the earth.

T F **15.** An extension cord is a temporary wiring used to supply power to portable electric tools and equipment.

T F **16.** Lockout is the process of placing a danger tag on the source of electrical power that indicates that the equipment may not be operated until the danger tag is removed.

T F **17.** A lockout device is a lightweight enclosure that allows the lockout of standard control devices.

T F **18.** A fixed ladder is a ladder that is permanently attached to a structure, tank, or vault.

T F **19.** The proper fall-protection equipment must be worn when working at heights greater than 5′ from the ground.

T F **20.** A lanyard is a rope or webbing that is attached to a worker and tie-off device to prevent the worker from hitting the ground or other object during a fall.

T F **21.** Rigging is the securing of equipment or materials in preparation for lifting by means of rope, cable, chain, or web sling.

T F **22.** A material lift is a mobile lifting apparatus used to transport, hoist, or stack materials using hydraulic and mechanical systems.

T F **23.** Confined spaces are entrapment hazards and expose workers to unsafe conditions such as oxygen deficiency, combustible gases, and/or toxic gases.

T F **24.** Bleeding is the most visible result of an injury.

T F **25.** Burns are caused by heat only.

Multiple Choice

______________ **1.** The ___ is a federal agency that requires all employers to provide a safe environment for their employees.

A. U.S. Department of Transportation (DOT)
B. Centers for Disease Control (CDC)
C. Occupational Safety and Health Administration (OSHA)
D. United States Department of Agriculture (USDA)

______________ **2.** The color ___ is used with safety color coding to indicate safety devices and locations of first aid equipment.

A. red
B. orange
C. green
D. yellow

________________ **3.** ___ are glasses with impact-resistant lenses, reinforced frames, and side shields.
A. Safety glasses
B. Goggles
C. Face shields
D. all of the above

________________ **4.** To start and sustain a fire, ___ must be present.
A. fuel
B. heat
C. oxygen
D. all of the above

________________ **5.** Class ___ fires include electrical equipment such as motors, appliances, wiring, fuse boxes, breaker panels, and transformers.
A. A
B. B
C. C
D. D

________________ **6.** A ___ liquid is a liquid that has a flash point below 100°F (38°C).
A. spontaneous
B. combustible
C. flammable
D. none of the above

________________ **7.** A ___ hazard is the degree of susceptibility of materials to release energy by themselves or by exposure to certain conditions or substances.
A. reactivity
B. health
C. flammability
D. specific

________________ **8.** On a safety data sheet, Section ___ provides information concerning component chemicals, quantity of chemicals, and Chemical Abstract Service (CAS) numbers.
A. II—Hazardous Ingredients/Identity Information
B. III—Physical/Chemical Characteristics
C. VIII—Control Measures
D. IX—Regulatory Information

________________ **9.** ___ is a heavy and dense material with a low melting point, low strength, and high rate of expansion.
A. Asbestos
B. Lead
C. Steel
D. none of the above

________________ **10.** The most common ___ are hydrogen sulfide and methane.
A. irritants
B. sewer gases
C. paint chemicals
D. hazardous materials

________________ **11.** A ___ is a device that protects against electrical shock by detecting an imbalance of current in the normal conductor pathways and opening the circuit.
A. tagout
B. lockout
C. ground-fault circuit interrupter (GFCI)
D. circuit breaker

________________ **12.** A(n) ___ is an adjustable-height ladder with a fixed bed section and sliding, lockable fly sections.
A. fixed ladder
B. single ladder
C. stepladder
D. extension ladder

________________ **13.** A ___ generally consists of metal or wood planks and metal bracing.
A. material lift
B. ladder
C. scaffold
D. all of the above

________________ **14.** Material handling is the ___ of a load by mechanical means.
A. rigging
B. lifting
C. transporting
D. all of the above

________________ **15.** The symptoms of ___ include excessive fatigue, dizziness, disorientation, and skin with a normal temperature but a damp and clammy feeling.
A. heat exhaustion
B. heat stroke
C. electrical shock
D. poisoning

Completion

________________ **1.** The color ___ is the safety color coding established by OSHA that is used to identify potentially dangerous parts of machines including exposed pulleys, gears, rollers, cutting devices, and power jaws.

________________ **2.** The ___ is the U.S. federal governmental department responsible for developing and executing U.S. government policy on farming, agriculture, and food.

____________________ **3.** ___ is safety equipment worn for protection against safety hazards in the work area.

____________________ **4.** ___ are ear protection devices worn over the ears.

____________________ **5.** A(n) ___ is a rubberized plastic or leather pad strapped to the knees for protection.

____________________ **6.** ___ is the use of metal-to-metal contact or a wire between two containers to prevent possible ignition from static electricity sparks.

____________________ **7.** ___ is self-ignition caused by a chemical reaction and temperature buildup in combustible waste material.

____________________ **8.** A(n) ___ hazard is the likelihood of a material to cause, either directly or indirectly, temporary or permanent injury or incapacitation due to acute exposure by contact, inhalation, or ingestion.

____________________ **9.** A(n) ___ is printed documentation used to relay hazardous material information from a manufacturer, importer, or distributor to a worker.

____________________ **10.** ___ is an inflammation caused by irritants, found on job sites, that come in direct contact with the skin.

____________________ **11.** A(n) ___ is a chemical agent that cleans and softens plastic pipe and fittings and allows solvent cement to penetrate more effectively into the pipe.

____________________ **12.** A(n) ___ is a condition that results when a body becomes part of an electrical circuit.

____________________ **13.** ___ is the process of removing the source of electrical power and installing a lock that prevents the power from being turned on.

____________________ **14.** A(n) ___ is a multiple-lockout/tagout device.

____________________ **15.** A(n) ___ is a folding ladder that stands independently of support.

____________________ **16.** The ___ of a scaffold is the total of all loads, including the working load, the weight of the scaffold, and any other loads that may be anticipated.

____________________ **17.** A(n) ___ is a person who has special knowledge, training, and experience in performing specified duties.

____________________ **18.** ___ is the hoisting of equipment or materials by mechanical means.

____________________ **19.** A(n) ___ is a space large enough and configured so a person can enter and perform assigned work, has limited or restricted means for entry and exit, and is not designed for continuous occupancy.

____________________ **20.** ___ occurs when the body's vital functions are threatened by lack of blood or when the major organs and tissues do not receive enough oxygen.

Short Answer

1. Explain the difference between a standards organization and a private organization.

2. List the personal protective equipment most commonly used in agricultural environments.

3. List three situations when a lockout/tagout must be used.

4. What is the difference between rigging and lifting?

5. What steps can be taken when trying to keep an injured person safe until professional help arrives?

Identification

NFPA Hazard Signal System

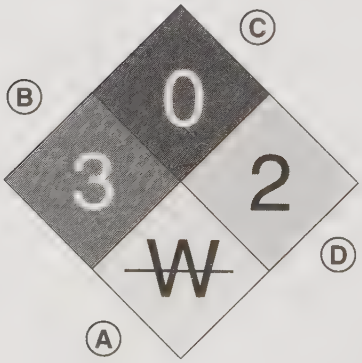
Identify the NFPA Hazard Signal System information.

______________ **1.** Flammability

______________ **2.** Health hazard

______________ **3.** Reactivity

______________ **4.** Specific hazard



OSHA Color Coding

Identify the OSHA color coding system information.

______________ **1.** Designates safety and location of first aid equipment

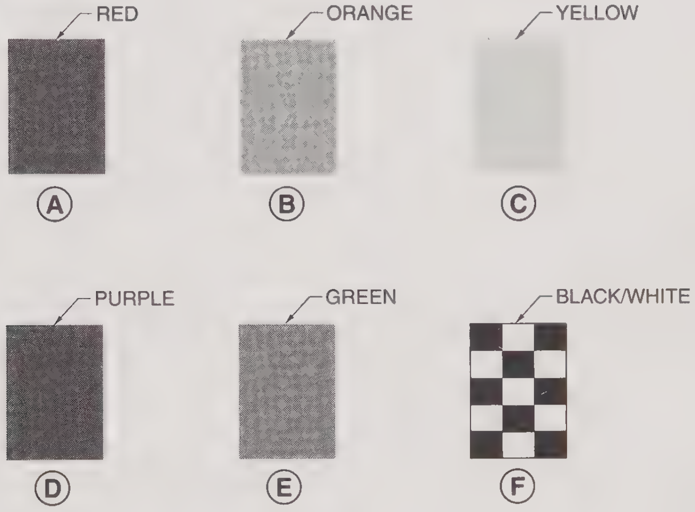
______________ **2.** Designates caution for physical hazards

______________ **3.** Designates dangerous parts of machines or energized equipment

______________ **4.** Identifies fire protection equipment, danger, and emergency stop devices

______________ **5.** Designates traffic and housekeeping areas

______________ **6.** Designates radiation hazards


RED
ORANGE
YELLOW
Ⓐ
Ⓑ
Ⓒ
PURPLE
GREEN
BLACK/WHITE
Ⓓ
Ⓔ
Ⓕ

Fire Classifications

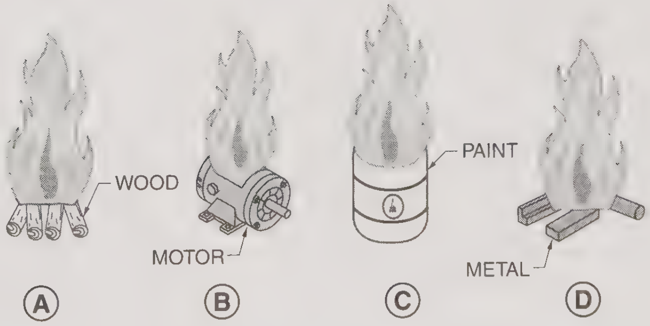
Identify the fire classifications.

______________ **1.** Class A fire

______________ **2.** Class B fire

______________ **3.** Class C fire

______________ **4.** Class D fire


WOOD
MOTOR
PAINT
METAL
Ⓐ
Ⓑ
Ⓒ
Ⓓ

Safety and Health 2

Activities

Name ______________________________ Date ________________

Activity 2-1: Personal Protective Equipment (PPE) Requirements

List the minimum PPE that must be worn in each of the following work applications.

1. Grinding steel workpiece with benchtop electric grinding wheel

2. Performing repair work on roof area of agricultural building

3. Performing work in or near silo containing grain or similar product

4. Performing work on or near equipment powered with exposed internal combustion engine (not in operator's cab)

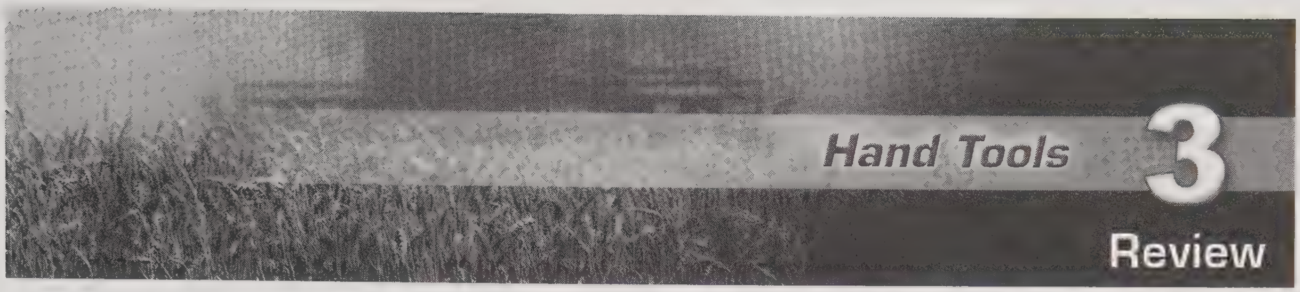
5. Installing nonelectric barb wire fencing

Activity 2-2: Conductive Material Identification

Identify the items that are considered conductive or nonconductive by placing a check mark in the appropriate box.

Conductive Material Identification

Item	Conductive	Nonconductive
Aluminum ladder		
Copper bracelet		
Fabric rope necklace		
Gold earrings		
Gold-plated ring		
Plastic necklace with metal inserts		
Rubberized floor mat		
Rubber insulating gloves with leather protectors		
Rubberized plastic bracelet		
Solid gold ring		
Stainless steel wristwatch		
Stainless steel wristwatch with leather band		
Standing water		
Steel scaffold with wooden platform		
Sterling silver necklace		
Wet concrete		
Wooden ladder		



Hand Tools

3

Review

Name ______________________________ **Date** ________________

True-False

T F **1.** Steel measuring tapes are typically no longer than 50′.

T F **2.** Tape rules, rules, and steel tapes are used to measure the lengths and widths of materials.

T F **3.** A carpenter's level is a vertical plane that is always at a right angle (90°) to a level surface.

T F **4.** A plumb line level consists of a slightly curved vial in a metal case that is hooked over a tightly stretched string to level across long distances.

T F **5.** Common marking and scribing tools include dividers, scratch awls, center punches, square gauges, and chalk lines.

T F **6.** A chalk line reel, or chalk box, is a small box filled with powdered chalk that holds a string wound around a spool.

T F **7.** A curved-claw hammer is used for rough work such as framing or concrete-form construction.

T F **8.** To prevent the hammer head from bouncing off the nail, bending it, or scarring the wood surface, the nail should be struck at an angle.

T F **9.** A hatchet is a striking tool that has both a nailing face and a cutting edge.

T F **10.** A hammer tacker is a heavy-duty stapler that allows one-hand operation and is used to fasten various materials, including vinyl flooring, insulation, roofing paper, screening, carpet padding, carpet, and ceiling tile.

T F **11.** Square-drive screwdrivers provide a means for reaching difficult screws.

T F **12.** A wrench is a hand tool designed to turn bolts, nuts, or pipes to either fasten or loosen them.

T F **13.** A crow bar is used as a wedge for separating items, pulling nails, and general prying.

T F **14.** Sawing and cutting tools are used to cut and trim materials to their proper dimensions.

T F **15.** A saw usually has a number printed on its blade indicating the number of teeth or points per inch.

T F **16.** A dovetail saw is used to cut curves and irregular lines in thin material.

T F **17.** Flooring chisels are forged from special hardened and tempered alloy steel and are used to cut through nails and other metals as well as stucco, plaster, and concrete.

T F **18.** Two common types of knives are utility and lineman's knives.

T F **19.** A taper tap is a tap used for hand tapping and when a workpiece must be tapped through.

T F **20.** Round dies are designed with thicker cross sections than hexagonal dies to permit cleaning and rethreading of threads.

T F **21.** A bar clamp consists of a solid bar, typically aluminum or steel, with a fixed head at one end and an adjustable tail stock.

T F **22.** A pipe vise is an assembly for holding pipe in place during cutting, threading, or grooving operations.

T F **23.** Common smoothing tools include bench planes, files, and rasps.

T F **24.** Two types of rabbet planes are the bullnose and adjustable bullnose rabbet planes.

T F **25.** Rasps are similar to files but are never used on wood.

Multiple Choice

______________ **1.** A laser hand level accurately projects a laser beam up to ___′.

A. 25
B. 50
C. 75
D. 100

______________ **2.** ___ tools are used to measure and mark angles during the fabrication of building materials.

A. Squaring
B. Marking and scribing
C. Fastening and prying
D. Sawing and cutting

______________ **3.** A ___ has an adjustable blade used to transfer or test specified angles.

A. rafter angle
B. sliding T-bevel
C. try square
D. framing square

____________________ **4.** The most commonly used size of curved-claw hammer is ___ oz.
A. 7
B. 16
C. 20
D. 24

____________________ **5.** Common types of ___ include the wallboard and shingling.
A. saws
B. wrenches
C. hammers
D. hatchets

____________________ **6.** The tip of a ___ screwdriver fits into a single slot on a screw head.
A. flat head
B. square-drive
C. star-shaped
D. cross-slot

____________________ **7.** Common types of ___ include combination, socket, adjustable, hex key (Allen), and pipe.
A. hatchets
B. saws
C. wrenches
D. hammers

____________________ **8.** ___ are hand tools that have opposing jaws for gripping or cutting.
A. Clamps
B. Screwdrivers
C. Fasteners
D. Pliers

____________________ **9.** Crosscut saws should be held at a ___° angle to the work surface to cut efficiently.
A. 20
B. 45
C. 70
D. 90

____________________ **10.** A ___ is used for skinning and scraping insulation off large gauge conductors and cables.
A. wire stripper
B. lineman's knife
C. file
D. chisel

____________________ **11.** A ___ tap is used to start a thread after a taper tap has been used.
A. plug
B. long shank
C. bottoming
D. all of the above

__________ **12.** A ___ is a fastening tool used to hold or secure workpieces together to prevent movement or separation.

A. clamp
B. bungee cord
C. crescent wrench
D. socket wrench

__________ **13.** A ___ clamp consists of a web belt that can be adjusted in length using a crank-type or ratchet-type handle.

A. spring
B. bar
C. band
D. corner

__________ **14.** ___ is the process of making holes by rotary drilling.

A. Tapping
B. Boring
C. Jointing
D. Digging

__________ **15.** A ___ is a general-purpose bench plane that is shorter in length than a jointer or a fore plane.

A. bullnose
B. rabbet
C. block
D. smooth plane

Completion

__________ **1.** A(n) ___ is any tool powered by hand.

__________ **2.** A(n) ___ is a measuring tool divided into even increments.

__________ **3.** A(n) ___ square is a 12″ metal rule with a sliding head.

__________ **4.** A(n) ___ square is a hand tool with a graduated blade attached at 90° to the handle and is used to measure, lay out, and verify the squareness of members.

__________ **5.** A(n) ___ is struck with a hammer to mark holes to be drilled in hardwood or metal.

__________ **6.** A(n) ___ is a striking or splitting tool with a hardened head fastened at a right angle to its handle.

__________ **7.** A(n) ___ allows one-hand operation because it releases a staple when struck against a surface in a hammering motion.

__________ **8.** A(n) ___ is a hand tool with a tip designed to fit into a screw head and, when turned, fastens or unfastens the screw.

____________________ **9.** A(n) ___ tool is a hand tool designed to pull apart materials that have been fastened together.

____________________ **10.** A(n) ___ is a wood-cutting hand tool consisting of a straight, toothed blade attached to a handle.

____________________ **11.** A(n) ___ is a hand tool with a cutting blade attached to a handle that cuts material when the end of the handle is struck by a hammer.

____________________ **12.** ___ are hand tools used to make straight cuts in light-gauge sheet metal.

____________________ **13.** ___ is the process of machining threads in a hole.

____________________ **14.** A(n) ___ is a tool with an internal thread similar to the thread in a nut that is used to cut external threads on bolts and on similar round metal or plastic stock.

____________________ **15.** ___ tools, such as picks and shovels, are used for tasks such as excavating trenches for concrete formwork.

____________________ **16.** A(n) ___ clamp is a woodworking clamp consisting of two wooden jaws connected by two parallel threaded rods with handles.

____________________ **17.** A(n) ___ is a portable or stationary clamping device used to hold work firmly in place.

____________________ **18.** ___ tools, including ratchet braces and hand drills, may be used on interior finish work.

____________________ **19.** ___ is the process of truing the edges of boards before they are fitted (joined).

____________________ **20.** A(n) ___ is an abrasive hand tool with single or double rows of fine teeth cut into the surface for use on metal workpieces.

Short Answer

1. List and describe common leveling and plumb tools.

2. What is the purpose of fastening and prying tools?

3. Explain the proper procedure for cutting material with a handsaw.

4. Describe the two types of knives commonly used for cutting construction materials.

5. What is the main difference between a file and a rasp?

Identification

Measuring Tools

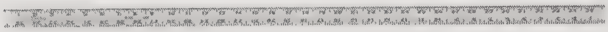
Identify the measuring tools.

______________ **1.** Folding rule

______________ **2.** Rule

______________ **3.** Steel tape

______________ **4.** Tape rule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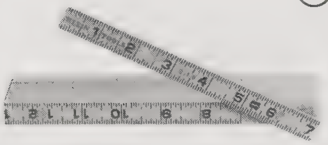
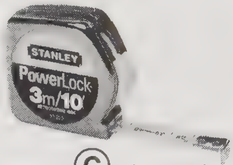

Ⓑ Klein Tools, Inc.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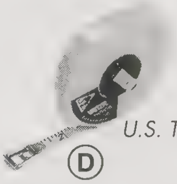

Ⓓ U.S. Tape

Leveling and Plumb Tools

Identify the leveling and plumb tools.

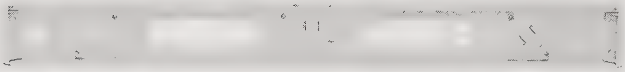
______________ **1.** Carpenter's level

______________ **2.** Laser hand level

______________ **3.** Line level

______________ **4.** Plumb bob and line

______________ **5.** Plate level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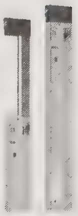
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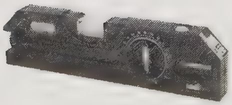
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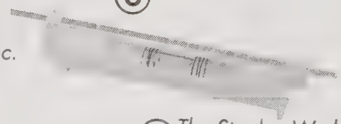
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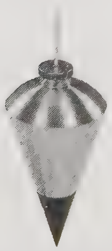
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Squaring Tools

Identify the squaring tools.

______________ **1.** Angle divider

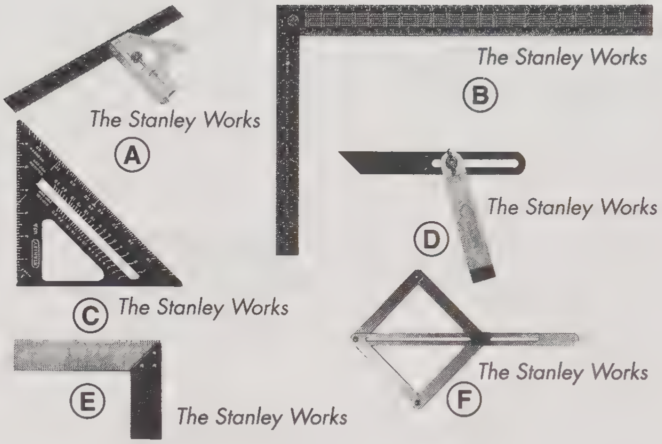
______________ **2.** Combination square

______________ **3.** Framing square

______________ **4.** Sliding T-bevel

______________ **5.** Speed square

______________ **6.** Try square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Marking and Scribing Tools

Identify the marking and scribing tools.

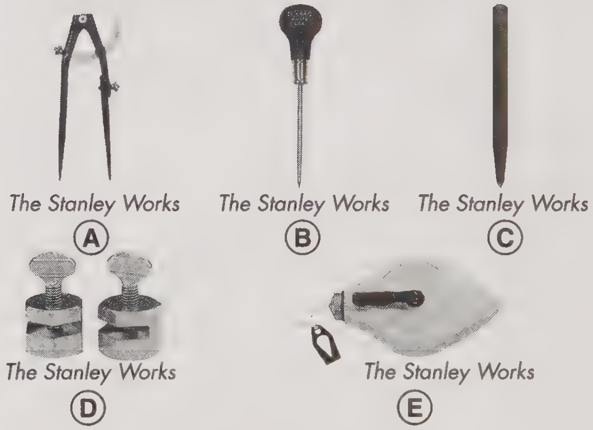
______________ **1.** Center punch

______________ **2.** Chalk line reel

______________ **3.** Divider

______________ **4.** Scratch awl

______________ **5.** Square gauges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Hammers

Identify the hammers.

______________ **1.** Ball-peen hammer

______________ **2.** Curved-claw hammer

______________ **3.** Dead blow hammer

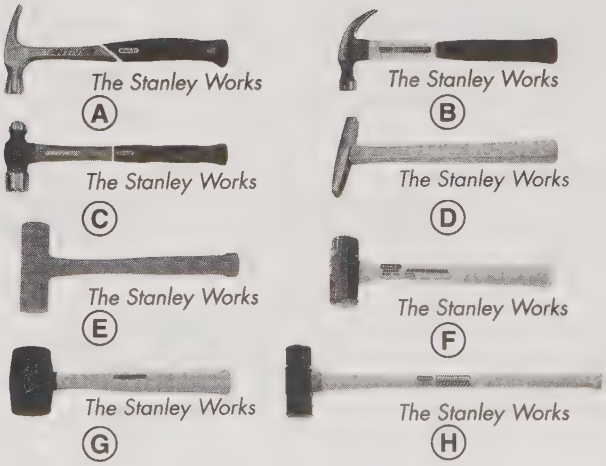
______________ **4.** Engineer's hammer

______________ **5.** Mallet

______________ **6.** Sledgehammer

______________ **7.** Straight-claw hammer

______________ **8.** Tack hammer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Screwdrivers

Identify the screwdrivers.

________________ **1.** Cross-slot (Phillips)

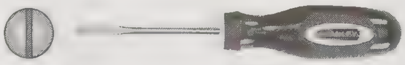
________________ **2.** Flat head

________________ **3.** Offset

________________ **4.** Screw-holding attachment

________________ **5.** Square-drive (Robertson)

________________ **6.** Star-shaped (Torx®)



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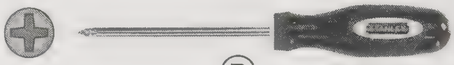

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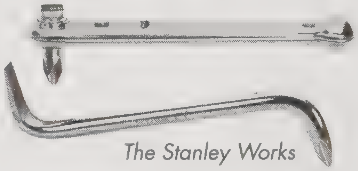

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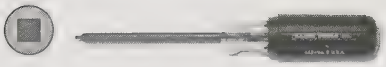

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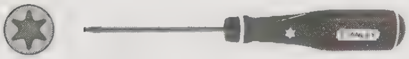

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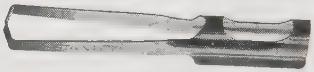

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Wrenches

Identify the wrenches.

________________ **1.** Adjustable wrench

________________ **2.** Combination wrench

________________ **3.** Hex key (Allen) wrench

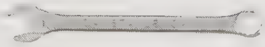
________________ **4.** Pipe (chain) wrench

________________ **5.** Pipe (offset) wrench

________________ **6.** Pipe (straight) wrench

________________ **7.** Pipe (strap) wrench

________________ **8.** Socket wrench



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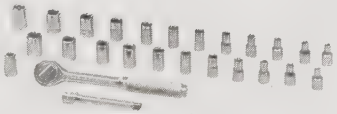

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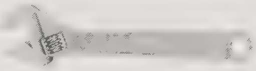

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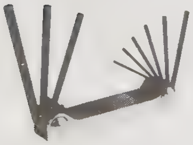

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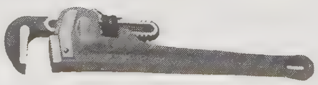
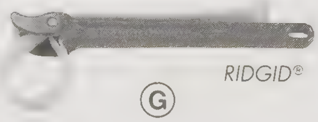


Ⓔ RIDGID®

Ⓕ RIDGID®



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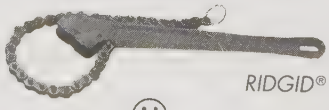

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Pliers

Identify the pliers.

________________ **1.** Diagonal-cutting pliers

________________ **2.** End-cutting pliers

________________ **3.** Lineman's pliers

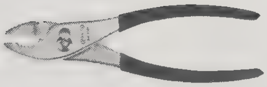
________________ **4.** Locking pliers

________________ **5.** Long nose pliers

________________ **6.** Self-adjusting pliers

________________ **7.** Slip-joint pliers

________________ **8.** Tongue-and-groove pliers



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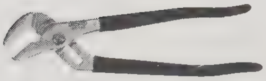

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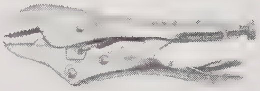

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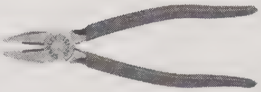

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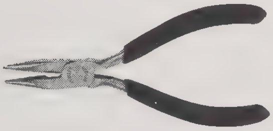

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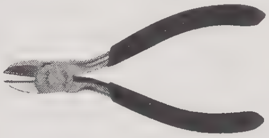

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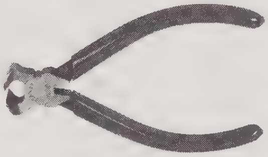

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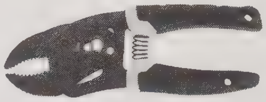

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Handsaws

Identify the handsaws.

________________ **1.** Backsaw

________________ **2.** Compass saw

________________ **3.** Coping saw

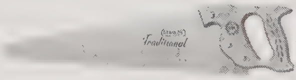
________________ **4.** Dovetail saw

________________ **5.** Keyhole saw

________________ **6.** Pistol-grip handle hacksaw

________________ **7.** Ripsaw or crosscut saw

________________ **8.** Straight handle hacksaw



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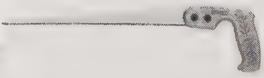

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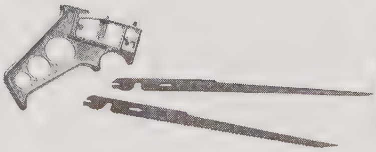

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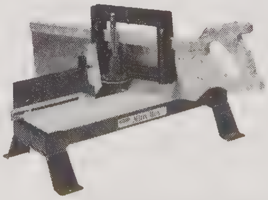

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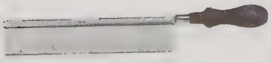

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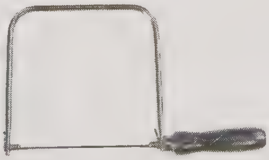

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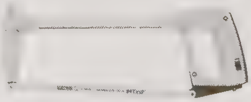

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Clamps

Identify the clamps.

________ **1.** Band clamp

________ **2.** Bar clamp

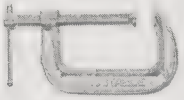
________ **3.** C-clamp

________ **4.** Corner clamp

________ **5.** Handscrew clamp

________ **6.** Spring clamp

________ **7.** Three-way edging clamp


Adjustable Clamp Company
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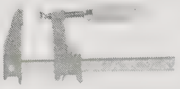
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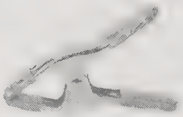
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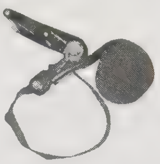
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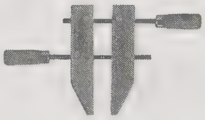
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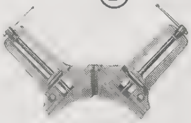
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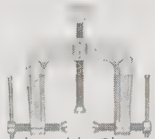
Adjustable Clamp Company
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Bench Planes

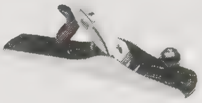
Identify the bench planes.

________ **1.** Block plane

________ **2.** Jointer and fore plane

________ **3.** Rabbet plane

________ **4.** Smooth plane


The Stanley Works
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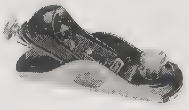
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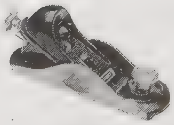
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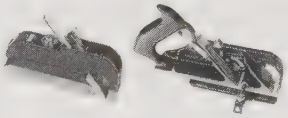
The Stanley Works
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Files

Identify the files.

________ **1.** Flat file

________ **2.** Half-round file

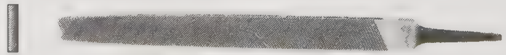
________ **3.** Knife file

________ **4.** Mill file

________ **5.** Round file

________ **6.** Square file

________ **7.** Three-square file

Ⓐ

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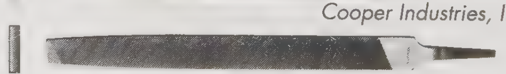
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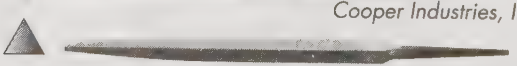
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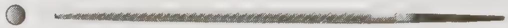
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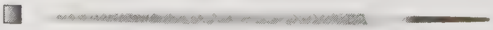
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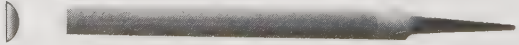
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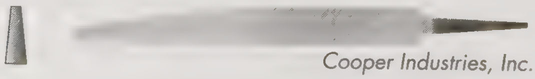
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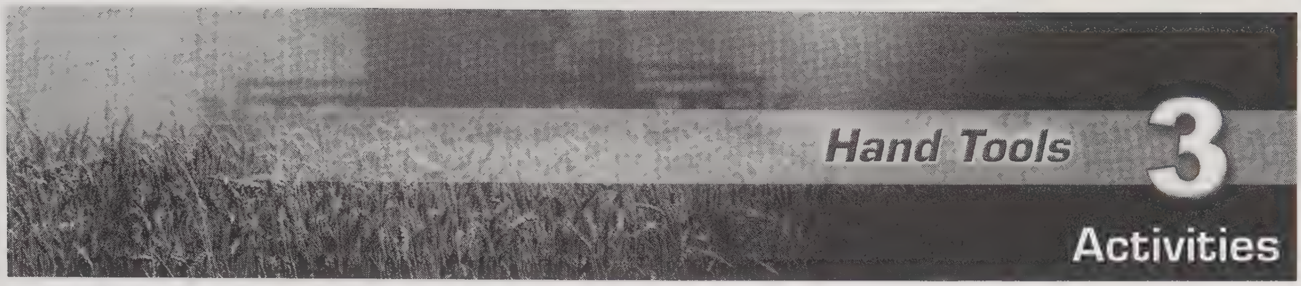


Hand Tools 3

Activities

Name ______________________________ **Date** ____________________

Activity 3-1: Math Calculations

Basic math calculations are often required when performing work with hand tools. Perform the following math calculations. Note: Display final answer in identical format.

______________ **1.** 3½ – 2¾ = ___

______________ **2.** 14⅞″ – 3¼″ = ___

______________ **3.** 2½ × 2½ = ___

______________ **4.** 14′-8″ – 6′-10″ = ___

______________ **5.** 6′-8″ + 3′-4″ + 12′-2″ = ___

______________ **6.** 48 ÷ ¾ = ___

______________ **7.** 25.55 × 31.10 = ___

______________ **8.** 6′-8½″ + 1′-6¼″ = ___

______________ **9.** 387 + 810 + 911 + 432 = ___

______________ **10.** 150.75 + 75.70 + 120.55 + 550.10 = ___

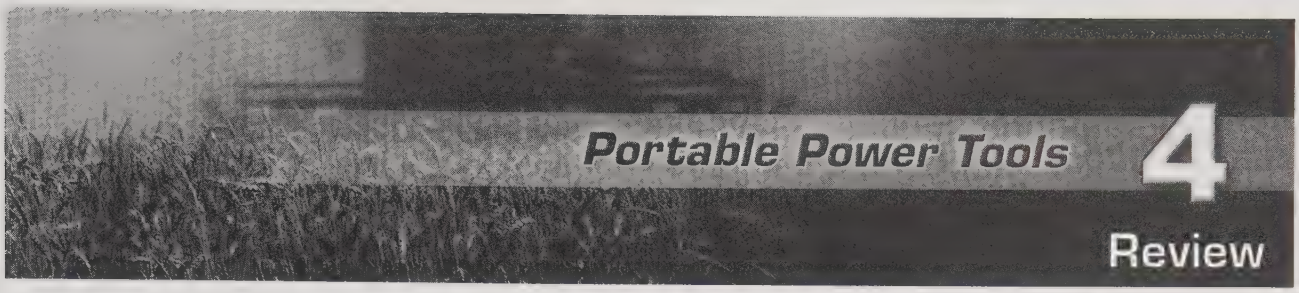
______________ **11.** 8′-10″ – 3′-11″ = ___

______________ **12.** 3 × 16 × 10 ÷ 4 = ___

______________ **13.** 16′-10¼″ – 9′-¾″ = ___

______________ **14.** ⅜′ – 3⁄16′ = ___

______________ **15.** 17′-6″ + 3′-2″ + 11′-9″ = ___



Portable Power Tools 4

Review

Name ____ Date ____________________

True-False

T F **1.** Portable power saws are primarily used to cut wood but can also be used to cut plastic and metal.

T F **2.** One of the biggest causes of circular saw injuries is the retractable guard failing to snap back into position after the cut is completed.

T F **3.** Circular saws operate similar to jigsaws but are used for heavy-duty applications, such as rough cuts in carpentry work where other tools cannot reach.

T F **4.** Drill bits have one or more cutting edges and one spiral or straight flute used for the removal of chips and the admission of cutting fluid.

T F **5.** The most frequently used drill bit for drilling small holes is a forstner drill.

T F **6.** A combination countersink and drill bit is an adjustable countersink cutter that is slipped over a twist drill and held in place with a socket setscrew.

T F **7.** Two factors that affect the drilling rate with a hammer-drill are speed and pressure.

T F **8.** Rotary hammers operate at a lower rpm than hammer-drills and should not be used to drill wood or metal.

T F **9.** Power screwdrivers are commonly used to install wall and ceiling materials over metal framing members and gypsum board over wood studs.

T F **10.** Power sanders are typically used to replace work performed by bench planes and reduce the amount of labor required to produce smooth surfaces and edges on stock.

T F **11.** Common portable power sanders include belt sanders and finish sanders.

T F **12.** There are only two types of finish sanders available: random orbital and palm.

T F **13.** Router bits are divided into very fine, fine, medium, coarse, and very coarse grades.

T F **14.** Pneumatic nailers and staplers are extensively used in framing as well as for attaching sheathing, light metals, and plastic materials.

T F **15.** Most pneumatic tools are powered by compressed air traveling through an air hose that is connected to an air compressor.

T F **16.** The nails used in framing nailers are round-head (full-head) or clipped-head.

T F **17.** A staple will split wood more easily than a nail when driven near the end of a board.

T F **18.** Powder-actuated tools operate on the direct-acting principle.

T F **19.** In general, powder-actuated tools are configured as single-shot, semiautomatic, and automatic.

T F **20.** Automatic tools feature a magazine that holds 12 nails or fasteners.

T F **21.** Powder loads are available as individual units for single-shot powder-actuated tools.

T F **22.** Threaded studs are more commonly used than drive pins.

T F **23.** When installing fasteners into concrete, the concrete thickness must be at least three times the fastener shank penetration.

T F **24.** Fastener shank length and powder load charge must be considered before installing drive pins.

T F **25.** Powder-actuated tools must not be used to drive fasteners into easily penetrated materials without backing material in place.

Multiple Choice

________________ **1.** Portable power tools and equipment are powered by ___.
A. electric motors
B. pneumatic systems
C. powder actuation
D. all of the above

________________ **2.** ___ blades have tungsten-carbide tips brazed to the teeth and are effective for cutting hard materials.
A. Abrasive
B. Carbide-tipped
C. Plywood
D. Rip

________________ **3.** A ___ is a portable power saw used to cut thin wood and nonwood products.
A. jigsaw
B. reciprocating saw
C. router
D. gullet

__________ **4.** A ___ is a rotary tool used with a bit with cutting edges for boring holes in rigid materials.
A. screwdriver
B. drill
C. saw
D. sander

__________ **5.** Drill bits are made of ___.
A. carbon steel
B. carbon steel with tungsten-carbide
C. high-speed steel (with molybdenum or cobalt added for hardness)
D. all of the above

__________ **6.** A ___ drill bit is a general purpose drill bit used to drill holes up to 1″ in diameter in wood or light gauge metal.
A. reduced-shank
B. spade
C. twist
D. none of the above

__________ **7.** A ___ drill bit is a drill bit with cutting edges on the bottom and side used to bore flat-bottom holes in wood.
A. ship auger
B. carbide-tipped
C. forstner
D. hole saw

__________ **8.** A(n) ___ is an electric or pneumatic tool used to bore holes up to ⅝″ in diameter in hard surfaces such as masonry and concrete.
A. hammer-drill
B. rotary hammer
C. impact wrench
D. power screwdriver

__________ **9.** ___ are used for a variety of applications, including installing and removing anchor bolt nuts, assembling metal building frames and panels, and driving lag bolts or screws.
A. Handheld grinders
B. Impact wrenches
C. Routers
D. Reciprocating saws

__________ **10.** Power drills, impact wrenches, and power screwdrivers use a(n) ___ motion during operation.
A. orbital
B. rotational
C. angular
D. rocking

__________ **11.** A ___ router bit is used to cut a 90° corner into a wood workpiece.
A. rabbeting
B. cove
C. dovetail
D. V-groove

__________ **12.** A portable power ___ is a cutting tool used for mortising and shaping operations, such as mortising door hinges or rounding the edges of a countertop.
A. plane
B. sander
C. router
D. none of the above

__________ **13.** A ___ router bit is used to cut a 45° mortise into a wood workpiece.
A. rabbeting
B. cove
C. 45° bevel chamfer
D. V-groove

__________ **14.** A ___ nailer is used for framing operations, including nailing studs to top and bottom plates and nailing joists and rafters to top plates.
A. framing
B. palm
C. cordless pneumatic
D. all of the above

__________ **15.** A(n) ___ is a one-piece fastener with a drive pin on one end and threads at the other.
A. unthreaded stud
B. threaded stud
C. staple
D. nail

Completion

__________ **1.** A(n) ___ is a handheld or table-mounted power saw with teeth around the circumference of a circular blade that is rotated at high speed on a central axis or shaft.

__________ **2.** ___ saw blades are used for both crosscut and ripping operations.

__________ **3.** A(n) ___ is a low area between the teeth of a saw blade.

__________ **4.** A(n) ___ saw is a multipurpose saw in which the blade reciprocates (quickly moves back and forth) to create the cutting action.

__________ **5.** A(n) ___ drill bit is a drill bit used to bore deep holes in wood up to 1″ in diameter.

__________ **6.** A(n) ___ drill bit is a rotating saw blade with a mandrel mounted in the center that is used to cut larger holes than can be cut with drill bits.

______________________ **7.** A(n) ___ is an electric tool with a drill bit that is rotated and moved with a percussive action to bore holes larger than ⅝″ in diameter into hard materials such as concrete or masonry.

______________________ **8.** A(n) ___ is a corded or cordless tool used for rapid and efficient driving or removal of screws.

______________________ **9.** A(n) ___ is a smoothing tool that removes excess wood and smooths the surface of wood using a straight or spiral cutter.

______________________ **10.** A(n) ___ is a recess or cavity in lumber or other material that receives a reverse-shaped member such as a tenon or lock.

______________________ **11.** A(n) ___ sander operates with an oscillating (back and forth) motion.

______________________ **12.** Common ___ nailers include framing, palm, and cordless.

______________________ **13.** ___ pressure for a pneumatic framing nailer should be adjusted so that nail heads are driven flush with or slightly below the material surface.

______________________ **14.** ___ nails are flat on one side and round on the other and are commonly used in areas with milder climates.

______________________ **15.** A(n) ___ tool is a tool that drives fasteners by means of an explosive charge.

______________________ **16.** ___ powder-actuated tools are adequate for construction projects requiring less frequent use of the tool.

______________________ **17.** The ___ loads used with a semiautomatic tool are attached to a strip or disk that is inserted into the tool.

______________________ **18.** A(n) ___ is a metal casing that contains a powder propellant and is crimped closed on the end and sealed.

______________________ **19.** ___ are used for permanent installation of materials or objects, such as a sill plate fastened to a concrete slab.

______________________ **20.** A(n) ___ test is a test used to determine the suitability of concrete for holding a powder-actuated fastener.

Short Answer

1. List and describe five different types of drill bits.

2. Explain how to affect the drilling rate of a hammer-drill.

3. What is a portable power plane used for?

4. What are the two basic types of fasteners used with powder-actuated tools?

5. Describe how a center point test is conducted.

Identification

Circular Saw Blades

Identify the circular saw blades.

______________ **1.** Abrasive blade

______________ **2.** Carbide-tipped blade

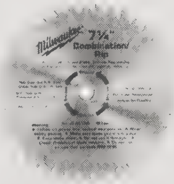
______________ **3.** Chisel-tooth combination blade

______________ **4.** Combination blade

______________ **5.** Crosscut plywood blade

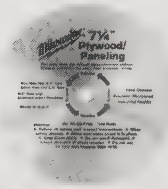
______________ **6.** Metal-cutting blade

______________ **7.** Rip blade


Milwaukee
7¼"
Combination/
Rip

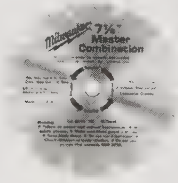
Milwaukee Electric Tool Corp.

Ⓐ


Milwaukee
7¼"
Plywood/
Paneling

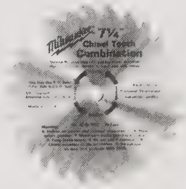
Milwaukee Electric Tool Corp.

Ⓑ


Milwaukee
7¼"
Master
Combination

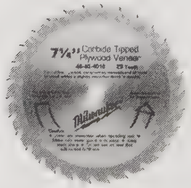
Milwaukee Electric Tool Corp.

Ⓒ


Milwaukee
7¼"
Chisel Tooth
Combination

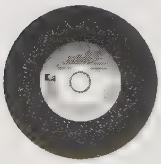
Milwaukee Electric Tool Corp.

Ⓓ


7¼" Carbide Tipped
Plywood Veneer
Milwaukee

Milwaukee Electric Tool Corp.

Ⓔ



Milwaukee Electric Tool Corp.

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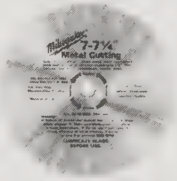

Milwaukee
7-7¼"
Metal Cutting

Milwaukee Electric Tool Corp.

Ⓖ

Drill Bits

Identify the drill bits.

______________ **1.** Carbide-tipped masonry drill bit

______________ **2.** Combination countersink and drill bit

______________ **3.** Forstner drill bit

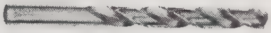
______________ **4.** Hole saw drill bit

______________ **5.** Ship augur drill bit

______________ **6.** Spade drill bit

______________ **7.** Twist drill bit – straight shank

______________ **8.** Twist drill bit – reduced shank


Milwaukee Electric Tool Corp.

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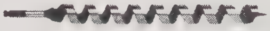
Milwaukee Electric Tool Corp.

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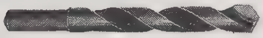
Milwaukee Electric Tool Corp.

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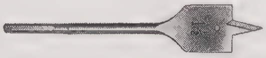
Milwaukee Electric Tool Corp.

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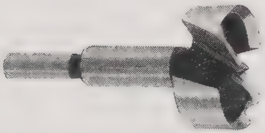
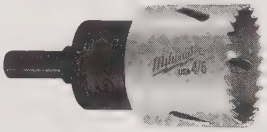

Milwaukee Electric Tool Corp.

Ⓔ


Milwaukee Electric Tool Corp.

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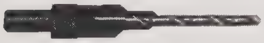

Milwaukee Electric Tool Corp.

Ⓖ

Milwaukee Electric Tool Corp.

Ⓗ

Portable Power Sanders

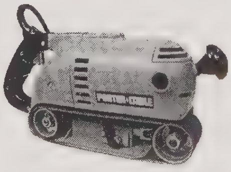
Identify the portable power sanders.

______________ **1.** Belt sander

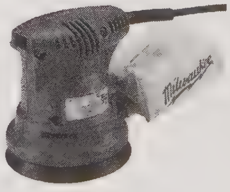
______________ **2.** Detail sander

______________ **3.** Palm sander

______________ **4.** Random orbital sander


Porter-Cable

Ⓐ


Milwaukee Electric Tool Corp.

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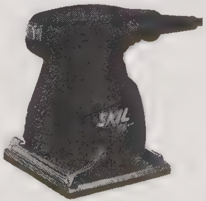
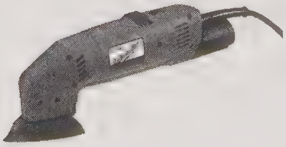

Skil Corporation

Ⓒ


Milwaukee Electric Tool Corp.

Ⓓ

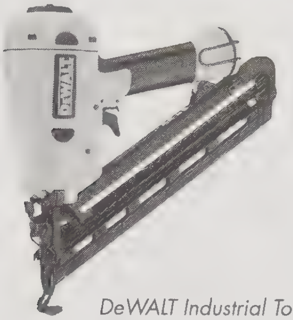
Pneumatic Nailers

Identify the pneumatic nailers.

______________ **1.** Cordless pneumatic nailer

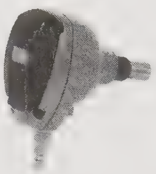
______________ **2.** Framing nailer

______________ **3.** Palm nailer



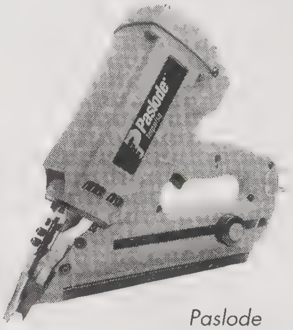
DeWALT Industrial Tool Co.

Ⓐ



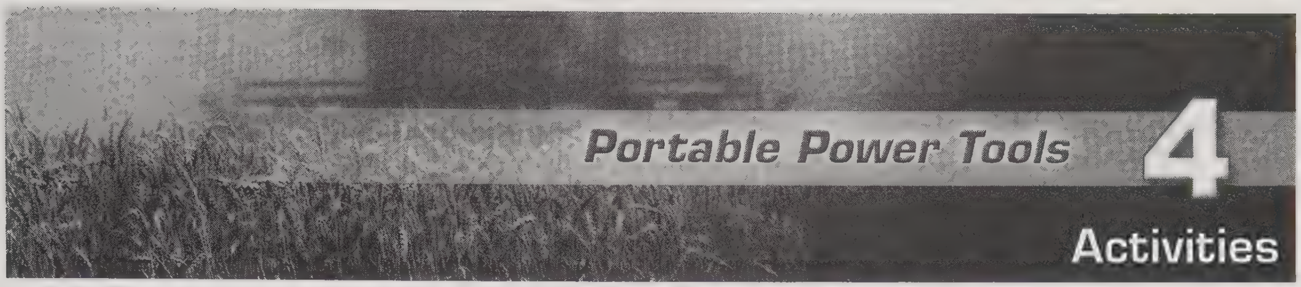
Senco Products, Inc.

Ⓑ



Paslode

Ⓒ



Portable Power Tools 4

Activities

Name ______________________________ Date ________________

Activity 4-1: Math Calculations

Basic math calculations are often required when performing work with portable power tools. Perform the following math calculations. Note: Display final answer in identical format.

______________ **1.** 1¾ of 20 = ___

______________ **2.** ⅞ × 1 × ¾ = ___

______________ **3.** 0.375 × 0.50 = ___

______________ **4.** 32.5 × 10.5 = ___

______________ **5.** 5.050 ÷ 25 = ___

______________ **6.** 215 × 0.540 = ___

______________ **7.** ⅜ × 2 = ___

______________ **8.** 16′-8½″ – 8′-9″ = ___

Activity 4-2: Effective Planning

Planning is essential to the efficient installation of materials, regardless of the type of materials being installed. One element of good planning is ensuring that the proper safety procedures, tools, and equipment are used for performing an operation.

1. List five safety tips for proper use of a circular saw.

2. List the tools required, including hand tools, required to measure, mark, and fabricate a wood chicken coop that measures 48″ L × 36″ W × 47″ H.

3. What type of saw blade(s) would work best when fabricating the chicken coop in question number 2?

Activity 4-3: Selecting and Purchasing Tools

1. Tools and equipment are typically available in several models and levels of quality to appeal to consumers and professionals. In general, professional-grade tools and equipment have greater durability and reliability than consumer-grade tools. Obtain tool and equipment manufacturer catalogs or visit their websites and compare and contrast specifications of common power drills.

2. Several companies specialize in tools and equipment used in agriculture. Contact tool and equipment manufacturers to request literature regarding their products. Review the product literature and compare and contrast the features of the tools and equipment. Develop a list of tools and equipment that an agricultural mechanic might purchase to perform basic repair and maintenance work on a farm.

Stationary Power Tools 5

Review

Name ______________________________ Date ____________________

True-False

T F **1.** Radial arm saws, table saws, miter saws, chop saws, and band saws are stationary power saws that can quickly and efficiently cut materials.

T F **2.** The portion of the blade below the table on a table saw is protected by the saw housing.

T F **3.** A miter saw can be rotated to the left and right up to approximately 50°, with positive stops at 0°, 15°, 22.5°, 30°, and 45°.

T F **4.** An electric motor on a power saw does not need to reach full speed before starting a cut on a workpiece.

T F **5.** Most band saws have variable-speed motors that can be changed to accommodate the cutting of various types of materials.

T F **6.** Band saws are available in only vertical models.

T F **7.** An advantage of using band saws is that they can be used to make precise and square finish cuts during fabrication.

T F **8.** A miter gauge must be used on a table saw for ripping operations.

T F **9.** A primary function of a band saw worktable is to provide a convenient work space for feeding the workpiece into the saw band while following the layout for the shape to be cut.

T F **10.** A cutting compound or lubricant must never be used when performing cutting operations with band saw blades.

T F **11.** If a drill press cannot be set to the exact speed required to make a cut, it should be set to the next faster speed on the machine.

T F **12.** A drill press is the most common cutting tool.

T F **13.** Most drill presses have circular columns, but some feature a square bar-section construction.

T F **14.** In the United States, peripheral speed is usually measured in units of feet per minute (fpm).

T F **15.** The most common type of metal used for constructing agricultural equipment and structures is mild steel.

T F **16.** While lathes may vary with respect to power options and controls, they typically have a bed, headstock, chuck, tailstock, and carriage.

T F **17.** The lathe spindle rotates a workpiece.

T F **18.** Most lathe chucks can have three or four jaws.

T F **19.** Lathe carriage movement can be accomplished by hand through use of the handwheel on the apron.

T F **20.** Cutting tools that are most commonly used with lathes are double-point cutting tools.

T F **21.** Common grinding machines include a bench grinder and surface grinder.

T F **22.** Bench grinding is performed with a horizontal or vertical grinding wheel to produce flat surfaces on workpieces held in place with a magnetic chuck on a worktable.

T F **23.** The table on most surface grinders is similar to the table on milling machines.

T F **24.** Coolant is sometimes referred to as cutting fluid.

T F **25.** The principal hazard while operating a grinder is injury to the arms, hands, or fingers from contact with the spinning grinding wheel.

Multiple Choice

____________ **1.** The size of a drill press is provided in terms of the ___.

A. maximum size of drill bit that the drill press can hold
B. diameter of the drill press column
C. distance from the drill press column to the point of the drill bit
D. size of the drill press spindle

____________ **2.** Due to the rotation of the blade, radial arm saws have a tendency to "___" forward (away from the fence) when the power is on but material is not being cut.

A. crawl
B. bounce
C. rotate
D. all of the above

______________ **3.** A table saw blade should protrude no more than ⅛″ to ___″ above the stock being cut.
A. ¼
B. ½
C. ¾
D. 1

______________ **4.** Metal chips are best removed from a drill press worktable with a ___.
A. rag
B. brush
C. hand
D. all of the above

______________ **5.** A ___ saw column encloses the return route for a saw blade and serves as a mounting point for machine controls.
A. band
B. chop
C. radial arm
D. miter

______________ **6.** A ___ blade makes it possible to cut refractory materials such as glass, tile, porcelain, ceramic, granite, china, marble, and silicon carbide.
A. rip
B. metal-cutting
C. diamond-tooth
D. combination

______________ **7.** ___ speed is the speed that a point on the outer edge of the cutting tool travels in a specific amount of time.
A. Rotational
B. Cutting
C. Blade
D. none of the above

______________ **8.** The major function of a lathe is to change the ___ of a cylindrical, rotating workpiece by one cut or a series of cuts into the workpiece with an adjustable cutting tool.
A. size
B. shape
C. finish
D. all of the above

______________ **9.** A ___ is the foundation on which a lathe is built.
A. carriage
B. bed
C. headstock
D. spindle

______________ **10.** A ___ is a device with adjustable jaws used to hold a cutting bit or drill bit on a lathe.

A. grinder
B. chuck
C. vise
D. headstock

______________ **11.** A ___ supports the cross slide, compound slide, tool post, and cutting tool on a lathe.

A. carriage
B. bed
C. headstock
D. spindle

______________ **12.** Grinders use the abrasive or cutting qualities of ___ or other materials bonded and formed into a wheel.

A. emery
B. corundum
C. silicon carbide
D. all of the above

______________ **13.** A ___ grinder is a stationary power tool capable of extremely close tolerances in dimension and finish.

A. base
B. bench
C. surface
D. all of the above

______________ **14.** An independent lathe chuck has ___ jaws.

A. two
B. three
C. four
D. six

______________ **15.** Grinding wheels (for surface or bench grinders) are classified according to the ___ used to join the grains.

A. abrasive material
B. grit number
C. type of bond
D. all of the above

Completion

______________ **1.** ___ saws are typically used for cutting trim members in finish work.

______________ **2.** A recommended safety tip for the use of a radial arm saw is to install ___ on both sides of a blade for ripping operations.

________________ **3.** A(n) ___ saw is a stationary power saw with a circular blade mounted on an arbor below the table.

________________ **4.** A(n) ___ is a device used with a table saw for the purpose of guiding a piece of material when performing crosscutting operations.

________________ **5.** An 8″ drill press is designed to drill a hole in the center of a circle that is ___″ in diameter.

________________ **6.** A(n) ___ saw is a stationary power saw that has a flexible saw blade that forms a continuous loop around two parallel wheels.

________________ **7.** The size of a band saw is measured by its ___ (the clearance between the column and the saw blade), which in turn determines the size of the workpiece the machine can handle.

________________ **8.** A band saw ___ houses the upper band wheel, which can be adjusted for saw band alignment.

________________ **9.** A(n) ___ is located near a welding and annealing station and is used to cut the saw band when it must be threaded through a workpiece for internal sawing operations.

________________ **10.** A(n) ___ grinder is used to dress the ends of a saw band before welding and to grind off the excess metal after the weld.

________________ **11.** A(n) ___ is a stationary power tool for drilling or modifying holes of various depths.

________________ **12.** Drill presses are available as a(n) ___- or floor-model type.

________________ **13.** The recommended drilling speed for mild steel is approximately ___ rpm.

________________ **14.** A(n) ___ is a stationary power tool that rotates a piece of wood or metal to allow shaping of the piece with sharpened or blunt tools.

________________ **15.** Three- and four-jaw ___ are made to fit screw-on, key-drive, and cam-lock type spindles.

________________ **16.** The ___ of a lathe is mounted at the right-hand end of the machine.

________________ **17.** A(n) ___ cutting tool is a relatively small piece of high-speed steel ground to form the cutting edges essential in removing metal efficiently.

________________ **18.** A(n) ___ is a stationary power tool used for quickly removing thin layers of material and/or improving surface finish.

________________ **19.** When cutting metal with a lathe, band saw, or drill press, a(n) ___ can be used to regulate the temperature of the work.

________________ **20.** ___ speed is the speed at which the cutting face of a grinding wheel travels and is measured in surface feet per minute (sfpm).

Short Answer

1. What is the difference between a radial arm saw and a table saw?

2. What is the principal purpose of a drill press?

3. Why must a cutting tool be ground to a precise form?

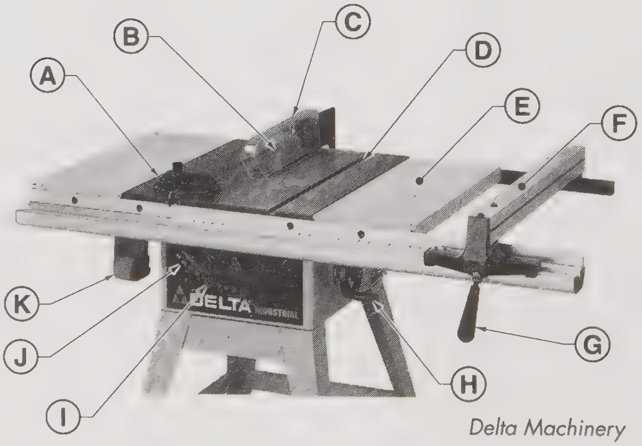
4. List the components of a lathe.

5. What is a bench grinder?

Identification

Table Saws

Identify the table saw components.



Delta Machinery

______________ **1.** Blade

______________ **2.** Blade height handwheel

______________ **3.** Fence lock clamp

______________ **4.** Miter gauge

______________ **5.** ON/OFF switch

______________ **6.** Rip fence

______________ **7.** Table

______________ **8.** Tilt handwheel

______________ **9.** Tilt scale

______________ **10.** Blade guard

______________ **11.** T-slot

Sliding Compound Miter Saws

Identify the sliding compound miter saw components.

______________ 1. Bevel-adjustment lever

______________ 2. Bevel scale

______________ 3. Blade

______________ 4. Blade guard

______________ 5. Fence

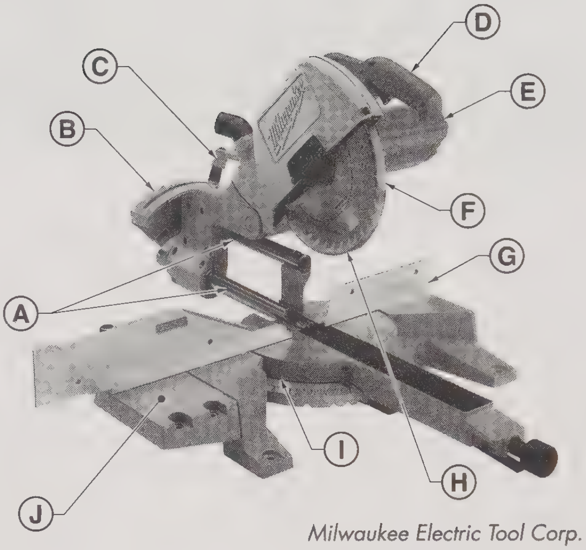
______________ 6. Guide tubes

______________ 7. Handle

______________ 8. Miter scale

______________ 9. Motor

______________ 10. Table



Milwaukee Electric Tool Corp.

Horizontal Band Saws

Identify the horizontal band saw components.

______________ 1. Band guide and support

______________ 2. Base

______________ 3. Blade

______________ 4. Blade tension knob

______________ 5. Coolant system

______________ 6. Gearbox

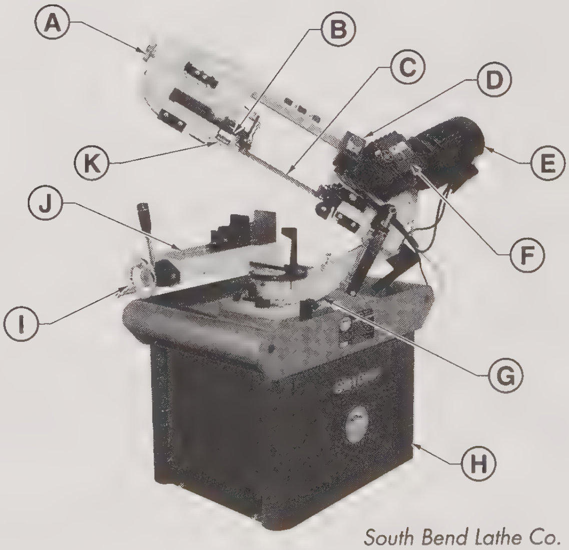
______________ 7. Head

______________ 8. Motor

______________ 9. ON/OFF button

______________ 10. Vise deck

______________ 11. Vise jaw handwheel



South Bend Lathe Co.

Drill Presses

Identify the drill press components.

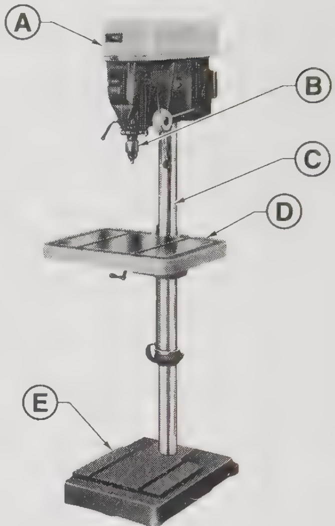
_______________ **1.** Base

_______________ **2.** Column

_______________ **3.** Head

_______________ **4.** Spindle

_______________ **5.** Table



Delta Machinery

Lathes

Identify the lathe components.

_______________ **1.** Bed

_______________ **2.** Carriage

_______________ **3.** Chuck

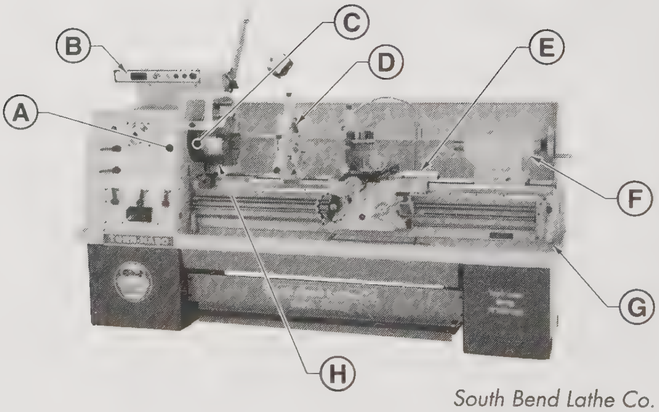
_______________ **4.** Control panel

_______________ **5.** Headstock

_______________ **6.** Spindle

_______________ **7.** Tailstock

_______________ **8.** Workpiece steady rest



South Bend Lathe Co.

Stationary Power Tools 5

Activities

Name ______________________________ **Date** ________________

Activity 5-1: Melting Points of Common Metals

Refer to Melting Points of Metals and Alloys in the Appendix to answer the following questions.

______________ **1.** The melting point of aluminum is about ___°F.

______________ **2.** The color of red brass is ___ when it reaches its melting point.

______________ **3.** The melting point of nickel is about ___°F.

______________ **4.** The melting point of mild steel is about ___°F.

______________ **5.** The color of mild steel is ___ when it reaches its melting point.

______________ **6.** The difference in melting points between pure iron and cast iron is between ___°F and ___°F.

______________ **7.** The color of aluminum when it reaches its melting point is ___.

______________ **8.** The melting point of copper is about ___°F.

______________ **9.** The melting point of lead is about ___°F.

______________ **10.** Copper's melting point is just above ___'s melting point.

Activity 5-2: Board Size Calculations

Stationary power tools such as table saws and miter saws are often used to cut many pieces of the same size. Answer the following questions based on basic workpiece calculations.

______________ **1.** How many 1¾″ strips may be cut from a 10″ wide wood board? (Allow ⅛″ for each saw kerf.)

______________ **2.** A 10″diameter saw blade has 60 teeth. How far apart are the teeth on the circumference of the blade?

______________ **3.** A 14″ board is cut into 12 equal lengths on a radial arm saw. How long is each piece? (Disregard saw kerf.)

Activity 5-3: Drill Speed Calculations

Certain planning must take place when preparing to use a drill press on metal workpieces, such as determining the proper cutting speed and choosing the correct cutting fluid. Answer the following questions and refer to Drill Press Cutting Fluids below and RPM Speeds for Fraction Size Drill Bits in the Appendix as required.

______________ **1.** What is the recommended drilling speed for a ¼″ drill bit used on mild steel?

______________ **2.** What is the recommended drilling speed for a ⅞″ drill bit used on mild steel?

______________ **3.** What cutting fluid(s) should be used when drilling tool steel?

______________ **4.** What cutting fluid(s) should be used when tapping machine steel?

______________ **5.** What cutting fluid(s) should be used when drilling cast iron?

______________ **6.** What is the recommended drilling speed for a 1¼″ drill bit used on mild steel?

______________ **7.** What cutting fluid(s) should be used when tapping aluminum?

______________ **8.** What is the recommended drilling speed for a 3″ drill bit used on mild steel?

______________ **9.** What is the recommended drilling speed for a 1⅝″ drill bit used on mild steel?

______________ **10.** What cutting fluid(s) should be used when drilling copper?

Drill Press Cutting Fluids

METAL	DRILLING	REAMING	TAPPING
Machine steel (hot and cold rolled)	Soluble oil Mineral lard oil	Mineral lard oil	Soluble oil Lard oil
Tool steel (carbon and high speed)	Soluble oil Lard oil with sulphur	Lard oil	Sulphur-base oil Mineral lard oil
Alloy steel	Soluble oil Mineral lard oil	Lard oil	Sulphur-base oil MIneral lard oil
Brass and bronze	Dry Lard oil Kerosene mixture	Soluble oil	Dry Soluble oil Lard oil
Copper	Soluble oil	Soluble oil	Soluble oil Lard oil
Aluminum	Kerosene Lard oil	Mineral lard oil	Soluble oil Mineral lard oil
Monel metal	Lard oil Sulphur-base oil	Mineral lard oil Sulphur-base oil	Mineral lard oil Sulphur-base oil
Malleable iron	Soluble oil	Soluble oil	Soluble oil
Cast iron	Dry	Dry	Small amount of mineral lard oil

Materials 6 Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** The two main classes that trees and lumber are divided into are softwood and hardwood.

T F **2.** Most lumber used for agricultural structures is hardwood.

T F **3.** Most lumber is produced using the quarter sawing method since it provides the widest boards and minimizes waste.

T F **4.** The two seasoning methods of lumber are air drying and kiln drying.

T F **5.** Lumber grade is based on its strength, stiffness, and appearance.

T F **6.** A pitch streak is an absence of wood or the presence of bark on the edge or corner of a piece of lumber.

T F **7.** A wane is a section of wood fibers saturated with enough pitch to be visible.

T F **8.** Common warped shapes are the crown, bow, twist, and cup.

T F **9.** The four conditions required for insect attack and deterioration to occur are moisture, oxygen, a temperature between 50°F to 90°F, and a food source such as wood fiber.

T F **10.** Oilborne preservatives are the most commonly used preservatives for agricultural applications.

T F **11.** Creosote is a coal tar distillate used to impregnate wood as a wood preservative.

T F **12.** The non-pressure-treating process of applying wood preservatives provides less protection than the pressure-treating process, but it is simpler and less expensive to apply.

T F **13.** A grade mark is used for pressure-treated lumber to provide information about the exposure conditions for proper use of the lumber and also indicate the type of preservative used on the lumber.

T F **14.** Ferrous metals are never magnetic.

T F **15.** Carbon steel is steel that is coated with a thin layer of zinc, which inhibits oxidation, rust, and corrosion.

T F **16.** The characteristics of materials are classified as mechanical, physical, or chemical properties.

T F **17.** Malleability is the force per cross-sectional area that a material can withstand before it fails.

T F **18.** The most common physical properties include appearance, texture, color, odor, melting point, boiling point, density, solubility, polarity, thermal conductivity, thermal expansion, conductivity, and resistance.

T F **19.** A chip test is a metal identification test in which a file is used to indicate the hardness of a metal compared to that of the file.

T F **20.** Extruding is a manufacturing process where molten metal is poured into a shaped cavity and the metal takes on the shape of the cavity as it cools and solidifies.

T F **21.** Casting is the process of pushing a material through a die to obtain the desired shape.

T F **22.** Case hardening is the process of increasing the hardness of a metal's surface without changing the mechanical properties of the core.

T F **23.** Plastic is a material composed of repeating groups of atoms or molecules linked in long chains known as polymers.

T F **24.** Thermoset plastic is a thin glass filament or strand that is formed by spinning or pulling molten glass into random lengths.

T F **25.** Plastics are typically used in agricultural applications in the form of pipes and in cultivation, harvesting, and processing equipment.

Multiple Choice

______________ **1.** ___-sawn lumber is lumber that is cut in a manner that is radially perpendicular to the growth rings of a tree.

- A. Plain
- B. Rift
- C. Quarter
- D. all of the above

______________ **2.** ___ is the most common type of damage caused by a fungus.

- A. Dry rot
- B. Blue stain
- C. Honeycomb
- D. White speck

__________ **3.** A(n) ___ metal is a metal that consists of one chemical element.

A. pure
B. ferrous
C. nonferrous
D. alloy

__________ **4.** A(n) ___ metal is a metal that does not contain iron.

A. pure
B. ferrous
C. nonferrous
D. alloy

__________ **5.** ___ is commonly used as an alloy with aluminum in castings requiring high strength with minimum weight.

A. Beryllium
B. Lead
C. Magnesium
D. Zinc

__________ **6.** ___ is strength under compressive forces, which squeeze a material.

A. Toughness
B. Malleability
C. Hardness
D. Compressive strength

__________ **7.** ___ is the characteristic of a material that causes the material to fracture without significant deformation.

A. Softness
B. Brittleness
C. Ductility
D. Malleability

__________ **8.** ___ is the change in volume of a material in relation to temperature.

A. Thermal expansion
B. Thermal conductivity
C. Oxidation
D. Melting point

__________ **9.** ___ is the combining of metals with elements in the surrounding environment that leads to the deterioration of a material.

A. Reduction
B. Conductivity
C. Corrosion
D. Thermal expansion

________________ **10.** A ___ test is a metal identification test that uses the application of heat to identify a metal by its color change, melting point, and behavior in the molten state.
A. file
B. magnetic
C. spark
D. torch

________________ **11.** A ___ test is a metal identification test that involves breaking a metal sample to check for ductility and grain size.
A. chip
B. fracture
C. brittleness
D. none of the above

________________ **12.** Common forming processes include ___, rolling, drawing, and extruding.
A. casting
B. forging
C. stamping
D. all of the above

________________ **13.** ___ is a manufacturing process in which a workpiece is deformed into the desired shape with high compressive forces, usually between two dies.
A. Forging
B. Casting
C. Stamping
D. Rolling

________________ **14.** ___ is the process of pulling a material through a die to shape the material to its final size and shape.
A. Extruding
B. Rolling
C. Drawing
D. Stamping

________________ **15.** A(n) ___ is a type of plastic that softens when heat is applied and re-forms into a solid when cooled.
A. thermoplastic
B. elastomer
C. thermoset plastic
D. none of the above

Completion

________________ **1.** ___ is wood that has been cut to specific sizes for building purposes.

________________ **2.** The two primary methods used to cut logs into lumber are plain sawing and ___ sawing.

______________________ **3.** ___ drying is usually used for higher grades of hardwood lumber used for finish work.

______________________ **4.** ___ lumber is primarily used for structural load-bearing applications and is graded for its strength.

______________________ **5.** ___ is a distortion that occurs during the evaporation of water from wood cells.

______________________ **6.** The best known oilborne preservative is ___.

______________________ **7.** A(n) ___ is a material consisting of one or more chemical elements having a crystalline structure, high thermal and electrical conductivity, the ability to be deformed when heated, and high reflectivity.

______________________ **8.** A(n) ___ metal is a metal that has iron as the primary alloying element.

______________________ **9.** ___ steel is steel containing carbon and small amounts of other material.

______________________ **10.** ___ is a lightweight, noncorrosive, nonmagnetic metal.

______________________ **11.** ___ is the ability of a material to resist deformation by indentation.

______________________ **12.** ___ is the ability of a material to be deformed by compressive forces without developing defects.

______________________ **13.** A(n) ___ is the temperature at which a solid changes to a liquid.

______________________ **14.** ___ is the ease or difficulty with which a material can be machined and is determined by its mechanical, physical, and chemical properties.

______________________ **15.** A(n) ___ test is a metal identification test that uses a magnet to check for the presence of magnetism in a metal.

______________________ **16.** A(n) ___ test is a metal identification test that identifies metal by the shape of its chips.

______________________ **17.** A(n) ___ process is a process that shapes a part prior to final machining operations.

______________________ **18.** ___ is a manufacturing process that involves forming sheet metal between dies with pressure while cutting the part from the sheet metal with the edge of the die.

______________________ **19.** ___ is the process of heating metal and then cooling it in oil, water, or another cooling medium to bring the temperature down quickly.

______________________ **20.** A(n) ___ is a flexible, rubberlike material that can be stretched up to twice its length and returns to its original length when released.

Short Answer

1. Describe the three most common sawing methods used to cut logs into lumber.

2. Explain the difference between a ferrous metal and a nonferrous metal.

3. List five types of identification tests used on metals.

4. Explain how heat treatment is used with metals.

5. What are the advantages of using plastic materials over other materials such as wood and metal?

6. Explain how wood shrinks in relation to grain direction.

7. What are two main advantages of quarter-sawn lumber over plain-sawn lumber?

8. What are the two main advantages of plain-sawn lumber over quarter-sawn lumber?

Identification

Tree Growth

Identify the tree growth rings.

__________________ **1.** Annual rings

__________________ **2.** Bark

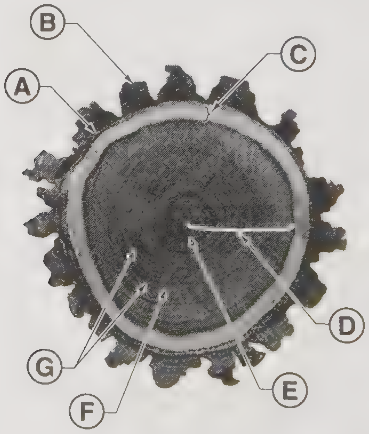
__________________ **3.** Cambium

__________________ **4.** Heartwood

__________________ **5.** Medullary ray

__________________ **6.** Pith

__________________ **7.** Sapwood



Lumber

Identify the lumber warpage or sawing methods.

______________ **1.** Bow

______________ **2.** Cup

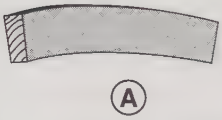
______________ **3.** Crown

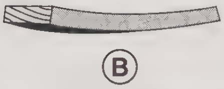
______________ **4.** Plain-sawn

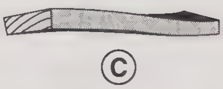
______________ **5.** Quarter-sawn

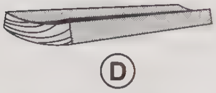
______________ **6.** Rift-sawn

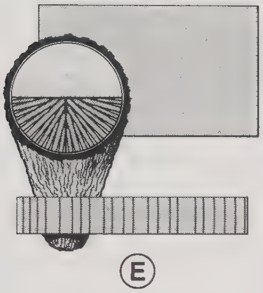
______________ **7.** Twist

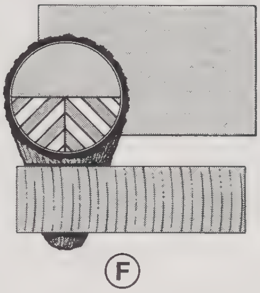


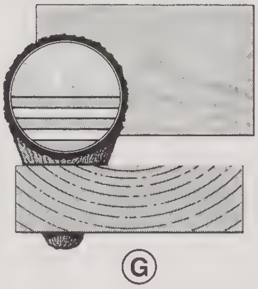












Lumber Grade Marks

Identify the lumber grade marks.

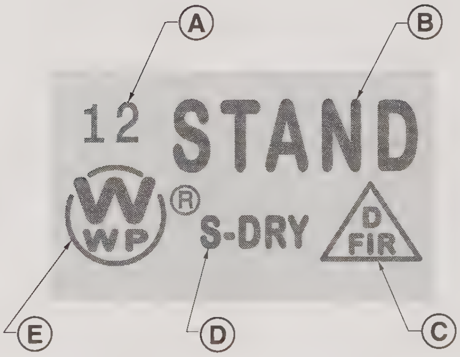
______________ **1.** Association certification trademark

______________ **2.** Condition of seasoning when surfaced

______________ **3.** Lumber grade

______________ **4.** Mill identification number

______________ **5.** Wood species



Mechanical Properties

Identify the mechanical properties.

______ **1.** Brittleness

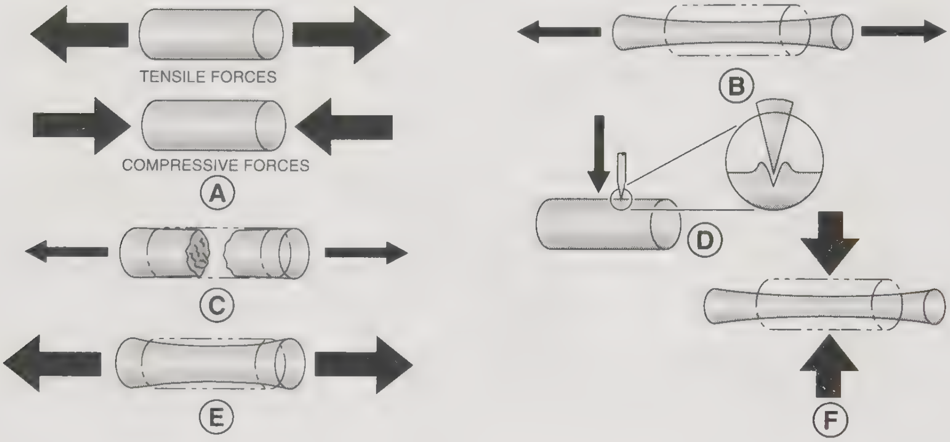
______ **2.** Ductility

______ **3.** Hardness

______ **4.** Malleability

______ **5.** Strength

______ **6.** Toughness


TENSILE FORCES
COMPRESSIVE FORCES
A
B
C
D
E
F

Forming Processes

Identify the forming processes.

______ **1.** Casting

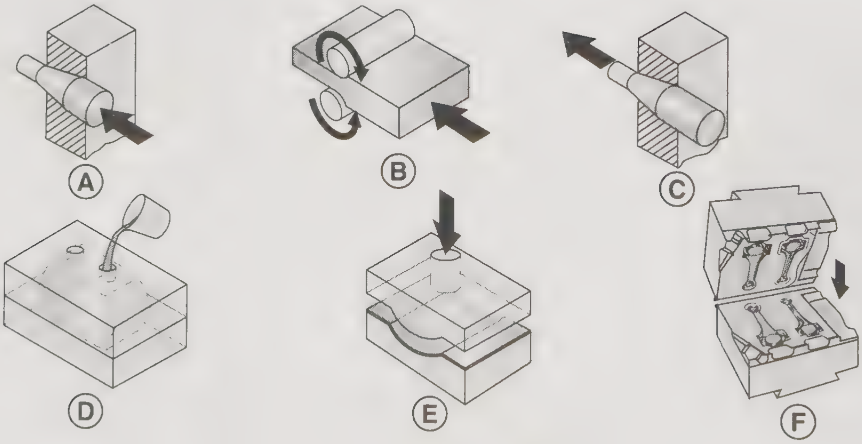
______ **2.** Drawing

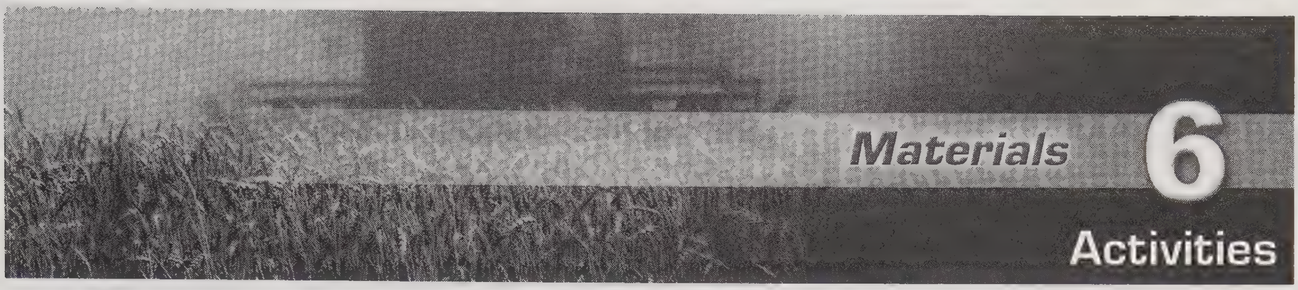
______ **3.** Extruding

______ **4.** Forging

______ **5.** Rolling

______ **6.** Stamping





Materials 6

Activities

Name ______________________________ **Date** ________________

Activity 6-1: Determining Lumber Material Cost

When operating a farm, lumber must occasionally be ordered. Calculate the cost of the following lumber orders.

A lumber order requires the following types of lumber:

- 10 boards of 6″ × 6″ × 12′ pressure-treated lumber at $2.83 per lineal foot
- 3.75 boards of 2″ × 10″ × 16′ kiln-dried whitewood at $0.86 per lineal foot
- 4 sheets of ⅜″ × 4′ × 8′ pine plywood at $16.35 per sheet

________________ **1.** What is the total material cost for this lumber order?

An order for hardwood lumber calls for the following:

- 150 board feet (BF) of 13⁄16″ Appalachian cherry at $2.25 per BF
- 75 BF of ½″ plain-sawn oak at $1.75 per BF

The sales tax on this order is 6%. Also, there is a 10% delivery charge. (*Note:* Do not figure sales tax on the delivery charge.)

________________ **2.** What is the total cost of this lumber?

________________ **3.** Cherry costs $3.46 per BF. How much will 132 BF of cherry cost?

________________ **4.** Sixteen board feet of maple at $4.02 per BF and three sheets of ¼″ luan mahogany at $18.32 per sheet will cost how much?

________________ **5.** A project requires 32 BF of 1″ cherry and 18 BF of 1″ oak. What percentage of the total wood required is oak?

________________ **6.** At $1.47 per BF, what is the cost of 172 BF of framing lumber?

Activity 6-2: Metals Identification

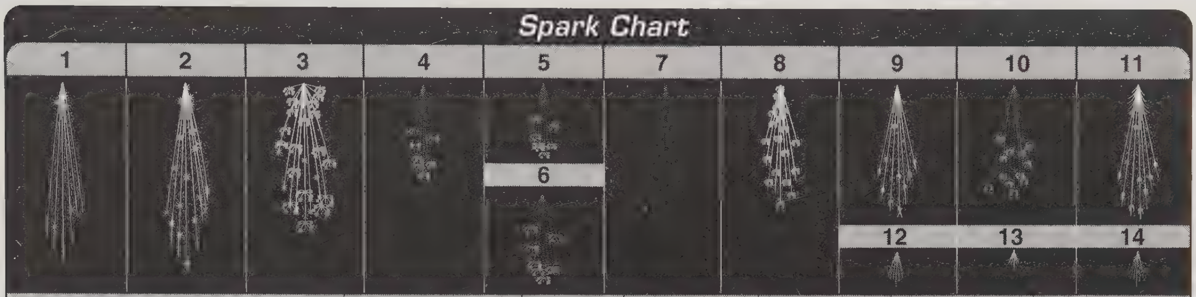
1. Refer to the Metal Identification chart to identify as many different types of metals as possible in the home, farm, school, or work area. Use a magnet as appropriate to determine if a metal is ferrous or nonferrous.

Metal Identification

METAL TYPE	PROPERTIES	AGRICULTURAL APPLICATIONS
Aluminum	Lightweight, electrical conductivity, flexible, silver color, nonferrous	Roofing, vehicle body panels, siding, electrical wiring, agricultural equipment components, fencing
Brass	Soft, flexible, corrosion-resistant, gold color, nonferrous	Water valves and fittings, marine equipment, spark-resistant tools, irrigation equipment
Bronze	Soft, flexible, corrosion-resistant, red-brown color, nonferrous	Light applications requiring corrosion resistance
Cast iron	Can be cast into any shape, brittle, tough, gray color, ferrous	Engine components, engine blocks, agricultural equipment components
Galvanized steel	Corrosion-resistant, tough, good tensile strength, silver-gray color, ferrous	Fencing, roofing, siding, water tanks, tower support, sheet metal products
Stainless steel	Hard, tough, corrosion-resistant, silver color, nonferrous	Dairy and food handling/processing equipment, bulk tanks and containers
Tin	Flexible, corrosion-resistant, silver color, nonferrous	Solder, plating
High-carbon steel	Hard, tough, good tensile strength, good machinability, silver-gray color, ferrous	Tools, tool bits, machine shop equipment
Copper	Flexible, electrical conductivity, corrosion- and spark-resistant, red-brown color, nonferrous	Electrical wiring, plumbing pipes, spark-resistant tools, electrical components, alloy with brass or bronze
Lead	Soft, heavy, blue-gray color, ferrous	Buckshot, battery terminals, solder, cable covering
Magnesium	Strong, tough, machinable, lightweight, silver-gray color, nonferrous	Aluminum alloy and castings, structural products, processing equipment

2. Use a bench grinder to grind consumable metal test specimens and note the colors of the sparks. Refer to the Spark Chart below or on page 160 of the textbook to identify the different types of metals. *Note:* Always wear proper PPE such as safety glasses or goggles, a face shield, and sturdy clothing when performing this test.

Spark Chart

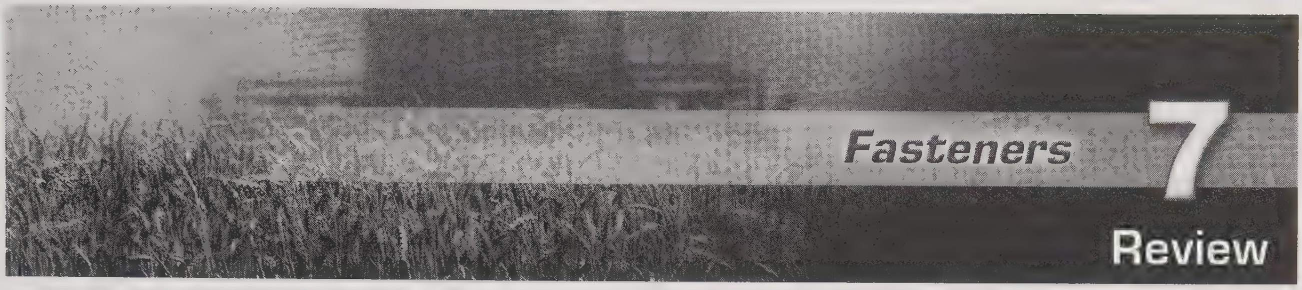


Metal	Stream Volume	Relative Length*	Color of Stream	Color of Bursts	Quantity of Bursts	Nature of Bursts
1. Wrought iron	Large	65	Straw	White	Very few	Forked
2. Machine steel (AISI 1020)	Large	70	White	White	Few	Forked
3. Carbon tool steel	Moderately large	55	White	White	Very many	Fine, repeating
4. Gray cast iron	Small	25	Red	Straw	Many	Fine, repeating
5. White cast iron	Very small	20	Red	Straw	Few	Fine, repeating
6. Annealed malleable iron	Moderate	30	Red	Straw	Many	Fine, repeating
7. High-speed steel (18-4-1)	Small	60	Red	Straw	Extremely few	Forked
8. Austenitic manganese steel	Moderately large	45	White	White	Many	Fine, repeating
9. Stainless steel (type 410)	Moderate	50	Straw	White	Moderate	Forked
10. Tungsten-chromium die steel	Small	35	Red	Straw†	Many	Fine, repeating†
11. Nitrided nitralloy	Large (curved)	55	White	White	Moderate	Forked
12. Stellite®	Very small	10	Orange	Orange	None	—
13. Cemented tungsten carbide	Extremely small	2	Light orange	Light orange	None	—
14. Nickel	Very small‡	10	Orange	Orange	None	—
15. Copper, brass, and aluminum	None	—	—	—	None	—

* actual length varies with grinding wheel, pressure, etc.
† blue-white spurts
‡ some wavy streaks

Activity 6-3: Plastics Identification

1. Make a list and identify as many different types of plastics as possible in the home, farm, school, or work area.



Fasteners 7

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** A shank is a ridge of uniform section in the form of a helix on the internal or external surface of a cylinder.

T F **2.** The dimensions of fastener threads are based on only their pitch.

T F **3.** There are numerous types of screw thread classifications used for bolts, but the two most common classifications in U.S. agriculture are the Unified Thread Standard (UTS) and metric thread identification.

T F **4.** Metric threads share the same basic profile as UN threads but differ in diameter and thread pitch, which are based on the metric system.

T F **5.** The class of thread indicates its tolerance and allowance.

T F **6.** A self-piercing screw is a fastener with a helical threaded shaft designed to grasp and hold in wood.

T F **7.** A wood screw is a threaded fastening device with a sharp point capable of penetrating and tapping thin metal.

T F **8.** Phillips-head concrete anchors are used when appearance is important or when the head must be flush with the surface.

T F **9.** The Society of Automotive Engineers (SAE) and ASTM International have established standards for classifying bolts and screws into grades based on their tensile strength and yield strength.

T F **10.** Spring lock washers are round and flat and are used under the head of a screw or bolt or under a nut to spread a load over a greater area.

T F **11.** An external tooth lock washer is the most commonly used tooth lock washer, but an internal tooth lock washer is used where it is necessary to consider appearance and to ensure engagement of teeth with the bearing surface of the fastener.

T F **12.** The simplest way to remove a damaged bolt or screw from a workpiece is to break off the head using a chisel and remove the threaded portion using an extractor.

T F **13.** Screws are the most commonly used type of wood fastener.

T F **14.** Common smooth-shank, ring-shank, screw-shank, or galvanized box nails are used when installing wall sheathing.

T F **15.** A disadvantage of box nails is that they bend more easily than common nails when driven.

T F **16.** A finish nail is a nail with a flared head.

T F **17.** Spiral-shank and ring-shank nails are two commonly used types of deformed-shank nails.

T F **18.** The stapling process can be automated with a hydraulic- or pneumatic-powered tool to save time.

T F **19.** Rivets are classified as large, medium, and small.

T F **20.** Slotted spring pins are tubular with one longitudinal slot, and both ends are chamfered.

T F **21.** Parallel keys are used for transmitting heavy unidirectional torques in shafts and hubs that are reversed frequently and subject to vibration.

T F **22.** Adhesives are classified by chemical content or base as acrylic, anaerobic, cyanoacrylate, epoxy, hot melt, polyurethane, polysulfide, silicone, solvent-base, or water-base adhesives.

T F **23.** Glues, in conjunction with nails, staples, or screws, are commonly used to hold together joints in mill and cabinet work.

T F **24.** A gypsum board is a narrow wood strip nailed to a wall or ceiling surface as a nailing base for finish materials.

T F **25.** Mastics provide an important structural function for glued floor systems by increasing the stiffness and strength of the floor unit.

Multiple Choice

______________ **1.** Threads are always assumed to be ___ unless otherwise specified.
A. external
B. internal
C. right-hand
D. left-hand

______________ **2.** A distinct feature of a thread is the ___.
A. flank
B. crest
C. root
D. all of the above

______________ **3.** The three classes of external threads are ___.
A. 1A, 2A, and 3A
B. 1B, 2B, and 3B
C. 1A, 2B, and 3A
D. 1B, 2A, and 3B

______________ **4.** The three classes of internal threads are ___.
A. 1A, 2A, and 3A
B. 1B, 2B, and 3B
C. 1A, 2B, and 3A
D. 1B, 2A, and 3B

______________ **5.** ___ screws screw into threaded holes in metal and have greater holding power than other types of screws that fasten to metal.
A. Self-tapping
B. Machine
C. Self-drilling
D. Concrete

______________ **6.** A(n) ___ is a steel rod threaded at one end used to secure structural members to concrete or masonry and formed in an L or J shape.
A. rivet
B. nut
C. anchor bolt
D. bolt

______________ **7.** A(n) ___ is a small metallic disc with a hole in its center.
A. anchor bolt
B. pin
C. nut
D. washer

______________ **8.** ___ washers have hardened teeth along an edge that are bent and offset in opposite directions to bite or grip both the work surface and the bolt head or nut.
A. Tooth lock
B. Spring lock
C. Plain
D. none of the above

______________ **9.** Nonthreaded fasteners include ___.
A. nails
B. rivets
C. staples
D. all of the above

______________ **10.** A ___ nail is a nail with a smooth shank and a small barrel-shaped head.
A. box
B. finish
C. rough work
D. duplex

______ **11.** A rivet ___ is the cylindrical body of a rivet.
A. head
B. grip
C. shank
D. all of the above

______ **12.** Standard ___ include straight, dowel, taper, clevis, cotter, grooved, slotted spring, and spirally coiled.
A. nails
B. rivets
C. staples
D. pins

______ **13.** The basic shapes of ___ include parallel, taper, and Woodruff.
A. dowels
B. keys
C. pins
D. rivets

______ **14.** A ___ is a removable part that provides a means of transmitting torque between a shaft and a hub when mounted in a keyseat.
A. key
B. washer
C. nut
D. pin

______ **15.** A staging nail is also referred to as a ___ nail.
A. box
B. casing
C. common
D. duplex

Completion

______ **1.** A(n) ___ is a component used for fixing the relative positions of parts in an assembly.

______ **2.** A(n) ___ is the surface on a fastener that joins the flanks and is identical in position with, or immediately adjacent to, the cylinder from which the thread projects.

______ **3.** ___ is the minimum clearance between the maximum dimensions of mating parts.

______ **4.** A(n) ___ is a metric bolt designation used to describe bolt strength and consists of two numbers separated by a decimal point.

______ **5.** Most screws are made of ___.

______ **6.** A(n) ___ screw is a threaded fastening device that, when driven into thinner metals, will drill a hole, cut threads, and fasten in one operation.

______ **7.** A(n) ___ is a piece of metal or other hard material that is female threaded to receive a bolt or other male-threaded device.

________________ **8.** ___ washers are split on one side and are helical in shape.

________________ **9.** A(n) ___ is a liquid coating applied to a threaded fastener to prevent the loosening of assembled parts from vibration, shock, and/or chemical leakage.

________________ **10.** A(n) ___ fastener is a device that joins or fastens parts together without threads.

________________ **11.** A(n) ___ nail has a smooth cylindrical shaft and a flat head.

________________ **12.** A(n) ___ is a thin, small nail made of wire with uniform thickness throughout and a small head.

________________ **13.** A(n) ___ is a U-shaped metal or wire fastener with pointed ends.

________________ **14.** A(n) ___ is a cylindrical metal pin with a preformed head.

________________ **15.** A(n) ___ is a cylindrical, nonthreaded fastener that is placed into a hole to secure the position of two or more parts.

________________ **16.** A(n) ___ is a void or groove in a member specifically designed to accept a corresponding projection from another member.

________________ **17.** ___ is the joining of parts with an adhesive placed between mating surfaces.

________________ **18.** ___ is the measure of the resistance of a fluid to flow.

________________ **19.** ___ resin is a type of plastic resin glue that is available in a powder form.

________________ **20.** ___ is a puttylike adhesive that maintains a degree of elasticity after setting.

Short Answer

1. List the thread types.

2. What are the three basic types of washers?

3. What is a threaded insert?

4. What is the main advantage of a Woodruff key?

5. What is the difference between low-viscosity adhesives and high-viscosity adhesives?

Identification

Wood Screw Head and Slot Types

Identify the wood screw head and slot types.

______________ **1.** Cross slot (Phillips)

______________ **2.** Flat head

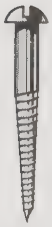
______________ **3.** Oval head

______________ **4.** Round head

______________ **5.** Slot

______________ **6.** Square (Robertson)

______________ **7.** Star-shaped (Torx®)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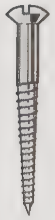
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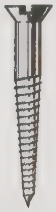
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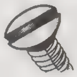
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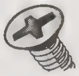
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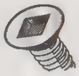
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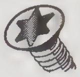
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Bolt Types

Identify the bolt types.

______________ **1.** Anchor

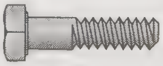
______________ **2.** Carriage

______________ **3.** Countersunk

______________ **4.** Hex

______________ **5.** Round head

______________ **6.** Square head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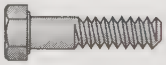
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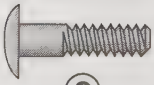
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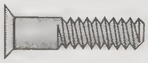
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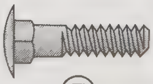
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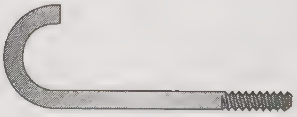
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Bolt and Screw Head Designs

Identify the bolt and screw head designs.

______________ **1.** Button

______________ **2.** Fillister

______________ **3.** Flat countersunk

______________ **4.** Headless

______________ **5.** Hex

______________ **6.** Hex washer

______________ **7.** 100° flat countersunk

______________ **8.** Oval countersunk

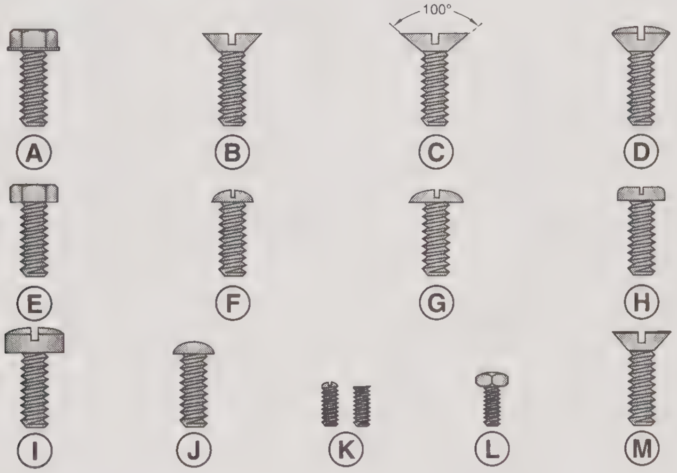
______________ **9.** Pan

______________ **10.** Round

______________ **11.** Round countersunk

______________ **12.** Square

______________ **13.** Truss



Drive Designs

Identify the drive designs.

______________ **1.** Drilled spanner

______________ **2.** Fluted socket

______________ **3.** Hex socket

______________ **4.** One-way

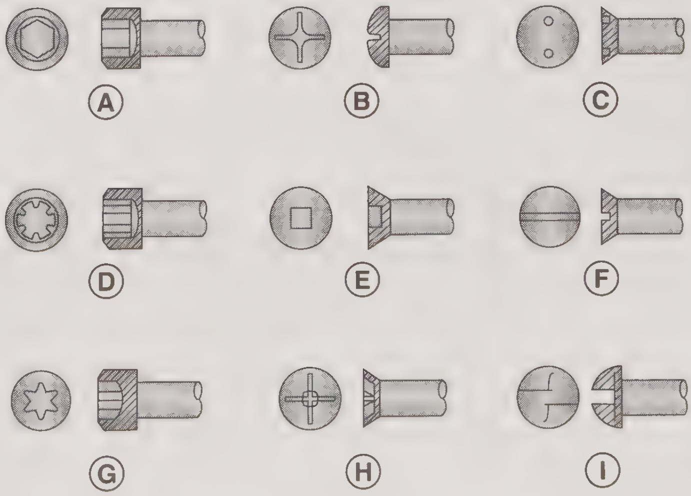
______________ **5.** Phillips recess

______________ **6.** Pozidriv® recess

______________ **7.** Slotted

______________ **8.** Square

______________ **9.** Torx®



Nut Designs

Identify the nut designs.

__________ **1.** Cap (acorn)

__________ **2.** Hex

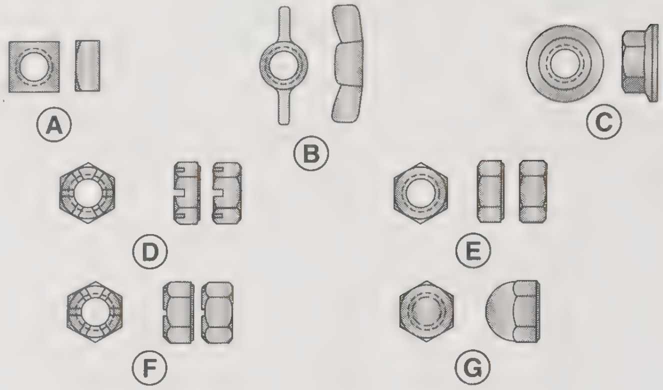
__________ **3.** Hex castle

__________ **4.** Hex flange

__________ **5.** Hex slotted

__________ **6.** Square

__________ **7.** Wing



Nail Heads

Identify the nail head types.

__________ **1.** Oval countersink

__________ **2.** Oval

__________ **3.** Round

__________ **4.** Floor brad

__________ **5.** Curved

__________ **6.** Flat countersink

__________ **7.** Flat

__________ **8.** Cupped

__________ **9.** Metal lath

__________ **10.** Hoop fastener

__________ **11.** Tree and pole dating

__________ **12.** Umbrella

__________ **13.** Lead head

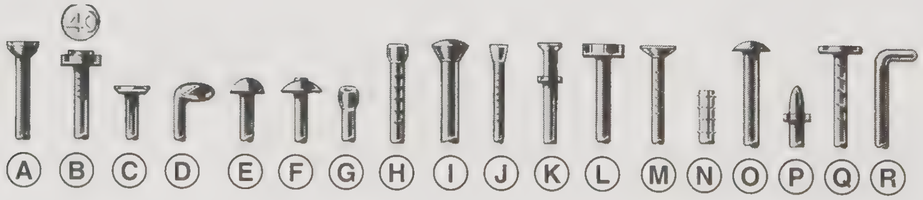
__________ **14.** Brad

__________ **15.** Headless

__________ **16.** Scaffold anchor

__________ **17.** Shade roller pin

__________ **18.** T-nail



Nails and Bolts

Identify the nail and bolt types.

______________ **1.** Flat-head stove bolt

______________ **2.** Machine bolt

______________ **3.** Carriage bolt

______________ **4.** Lag bolt

______________ **5.** Round-head stove bolt

______________ **6.** Round shank nail

______________ **7.** Barbed nail

______________ **8.** Longitudinally grooved nail

______________ **9.** Screw nail

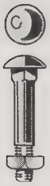
______________ **10.** Spiral nail

______________ **11.** Oval nail

______________ **12.** Triangle nail

______________ **13.** Square nail

______________ **14.** Annular nail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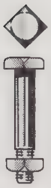
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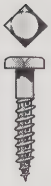
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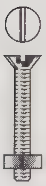
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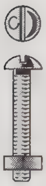
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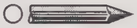
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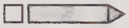
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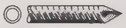
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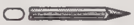
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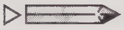
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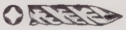
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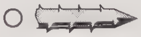
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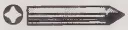
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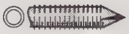
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Matching

Fasteners

Match the fastener with its description.

______________ **1.** Deformed shanks

______________ **2.** Screw

______________ **3.** Urea resin

______________ **4.** Adhesives

______________ **5.** Staples

______________ **6.** Bolts

______________ **7.** Contact cement

______________ **8.** Nail

A. Used for lighter applications

B. Adhesive for plastic laminates

C. Barbs, spirals, and rings

D. Made primarily of soft steel

E. Powdered plastic resin glue

F. Primary type of wood fastener

G. Glues and mastics

H. Used when removal of fasteners is required

Adhesives

Match the adhesive with its description.

____________________ **1.** Contact cement

____________________ **2.** Mastic

____________________ **3.** Phenolic resin

____________________ **4.** Resorcinol resin

____________________ **5.** Urea resin

A. Available in a powder form; mixed with water to form excellent bond for wood to wood application; has fair moisture resistance

B. Has moisture resistance and resistance to extreme temperature fluctuations; creates a strong bond; frequently used for bonding the wood layers of glulam timbers

C. Used to bond various materials directly to masonry or concrete walls; has a puttylike consistency

D. Primarily used to bond plastic laminates to wood surfaces; has a neoprene rubber base; used to join parts that are difficult to clamp together

E. Has moisture resistance and resistance to extreme temperature fluctuations; commonly used to bond the veneer layers of exterior grade plywood

Fasteners 7

Activities

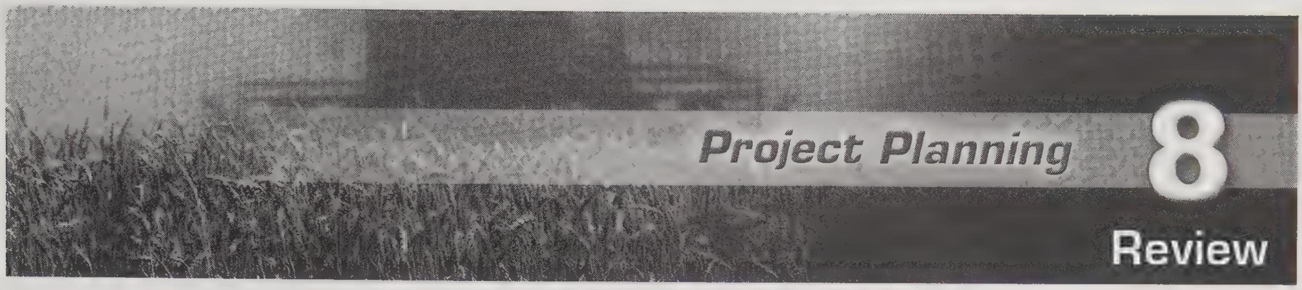
Name ____ Date ________________________

Activity 7-1: Adhesive Application and Safety

1. Refer to the manufacturer's websites for three different types of adhesives and read the manufacturer's instructions. List the method of application and safety precautions for each type.

Activity 7-2: Fastener Applications

1. Review all fastened items on a farm or particular area of a farm and list the type of application and fastener used for each application.



Project Planning

8

Review

Name ______________________________ Date ________________

True-False

T F **1.** A print includes a detailed analysis of the current and future needs and the anticipated improvements necessary to meet those needs.

T F **2.** A windbreak is a clustered section of trees or shrubs used to break the force of the wind for the purpose of protecting structures and crops.

T F **3.** Because a sketch does not actually contain a third dimension, the multiview plane is where the components of a sketch are arranged in a specific order to create the illusion of space.

T F **4.** Isometric sketches are a type of multiview sketch that use multiple views to show the object from different orientations.

T F **5.** Sketches are never drawn to a specific scale.

T F **6.** A drawing is an assembly of lines, dimensions, and notes used to convey general or specific information as required by the application and use.

T F **7.** Any drawing can be customized to show as much detail as required.

T F **8.** Technical drawings are used when it is necessary to present a design idea that is accurate and scientifically correct so that individuals with little technical knowledge or training can visualize and understand the idea as it is presented.

T F **9.** A sketch is a drawing of an object as it is viewed from above.

T F **10.** A floor plan is a plan view looking down at a building from approximately 5′-0″ above the floor.

T F **11.** A line is a straight mark that begins at a starting point and stops at an endpoint.

T F **12.** A symbol is a letter or group of letters that represent a term or phrase.

T F **13.** The number and type of schedules increase with the complexity of the project.

T F **14.** Print conventions typically govern the display of notes, detail symbols, section symbols, and column numbers and/or letters.

T F **15.** A mechanical engineer's scale is a flat scale used to draw large areas, such as property lines, on a plot plan.

T F **16.** A bill of material is written information included with a set of prints.

T F **17.** Dimensions are placed on a drawing so that they allow only one interpretation and include no repetition.

T F **18.** A setback is the distance required between a structure on a piece of property and the property line.

T F **19.** Concept estimates are prepared as the development process proceeds toward completion.

T F **20.** The bidding process ends once construction documents are complete and the project owner has secured the financing and is ready to start the construction.

T F **21.** The estimating process begins with a review of all construction contract documents, including detail drawings, specifications, addenda, and agreement forms.

T F **22.** Conditions that may change include weather, job-site conditions, architectural drawings, subcontractors, suppliers, and local government agencies.

T F **23.** Labor is a low-risk item in an estimate.

T F **24.** A bill of materials contains an abbreviation and/or symbol, a quantity, manufacturer model information, and a description for each item.

T F **25.** Project scheduling affects the estimated costs for materials, labor, and overhead.

Multiple Choice

______________ **1.** A ___ is a two-dimensional visual representation of an object at a chosen angle and distance.

A. sketch
B. plan
C. drawing
D. all of the above

______________ **2.** A ___ is a two-dimensional space on paper where the flattened image of a three-dimensional object is depicted.

A. pictorial drawing
B. picture plane
C. sketch
D. multiview sketch

_______________ **3.** A(n) ___ sketch describes a three-dimensional object in a two-dimensional space.
A. multiview
B. isometric
C. orthographic
D. none of the above

_______________ **4.** ___ display enough information to produce a visual picture but typically do not include dimensions.
A. Detail drawings
B. Technical drawings
C. Multiview sketches
D. Pictorial drawings

_______________ **5.** A(n) ___ drawing shows how the individual parts of an object work together.
A. pictorial
B. detail
C. sectional
D. orthographic

_______________ **6.** A(n) ___ drawing shows as closely as possible the way individual parts or components are placed together to produce a finished piece of equipment or result.
A. orthographic
B. pictorial
C. assembly
D. sectional

_______________ **7.** Types of plans most commonly referenced for project planning are plot plans, foundation plans, and ___ plans.
A. structural
B. utility
C. floor
D. all of the above

_______________ **8.** A ___ plan indicates the type, amount, placement, and fabrication of all materials used as structural supports of a building, bridge, or other structure.
A. structural
B. plot
C. foundation
D. floor

_______________ **9.** Sets of ___ can include plot plans (site plans), floor plans, elevations, sectional views, wiring diagrams, details, and schedules.
A. drawings
B. plans
C. prints
D. sketches

______________ **10.** A ___ is a system of drawing representation in which drawing elements are proportional to actual elements.

A. print convention
B. title block
C. drawing scale
D. none of the above

______________ **11.** A(n) ___ is a numerical value that gives the size, form, or location of objects on a drawing.

A. dimension
B. symbol
C. abbreviation
D. unit

______________ **12.** A(n) ___ is a symbol on a print or drawing at the front end of a dimension line that indicates the extent of a dimension.

A. circle
B. arrowhead
C. bullet
D. square

______________ **13.** A(n) ___ is a formal approval legally required by local or state building authorities for initiating new construction and major renovations.

A. authority having jurisdiction (AHJ)
B. building code
C. bid proposal
D. building permit

______________ **14.** A ___ includes pricing, performance criteria, and scheduling and staffing information as needed by the owner for selection of the contractor or contracting team.

A. bill of materials
B. bid estimate
C. bid proposal
D. cost estimation

______________ **15.** A ___ is a written list of parts or components that are required to build a specific product.

A. bid estimate
B. bill of materials
C. bid proposal
D. all of the above

Completion

______________ **1.** A(n) ___ plan is a scale drawing in a plan view format of existing and future farm facilities as planned by the owner of the business.

________________ **2.** ___ is a method of quickly marking a structure of an object on a sketch by breaking the subject into common shapes and lines.

________________ **3.** ___ sketches are drawn around a vertical axis, a 30° axis to the right, and a 30° axis to the left.

________________ **4.** A(n) ___ drawing is a three-dimensional drawing that resembles a picture.

________________ **5.** A(n) ___ drawing is a type of drawing that indicates the internal features of an object.

________________ **6.** A(n) ___ is a type of drawing where all surfaces (front, top, and side) of an object are projected onto flat planes that generally are at 90° (right) angles to one another.

________________ **7.** A(n) ___ plan is a type of drawing that shows the property lines of a building lot, the elevation, the compass directions, the lengths of property lines, and locations of structures.

________________ **8.** ___ plans are used to provide excavating, construction, drainage, waterproofing, and other design information for building the foundation.

________________ **9.** A(n) ___ plan is a type of drawing that indicates the location of utilities such as electrical, water, sewage, gas, and communication services.

________________ **10.** A(n) ___ is a reproduction of original drawings created by an architect or engineer.

________________ **11.** A(n) ___ block is an area on a working drawing or print used to provide information about the drawing or print.

________________ **12.** A print ___ is a chart used to conserve space and display information on a print in a concise and organized format.

________________ **13.** A(n) ___ block identifies the changes that have been marked on the drawing since its initial approval.

________________ **14.** A print ___ is an agreed-upon method of displaying information on a print.

________________ **15.** Locations of trees, rocks, ponds, creeks, and property drainage may be located on a(n) ___ plan.

________________ **16.** A(n) ___ line is a line that is used with dimensions to show size or location.

________________ **17.** A(n) ___ estimate is an estimate in which each individual construction component is accounted for, or taken off.

________________ **18.** ___ is the practice of reviewing construction contract documents to determine the quantities of materials to be included in a bid.

________________ **19.** The ___ is the organization, office, or individual responsible for approving the equipment and materials used for building construction.

________________ **20.** The two most common Federal agencies that regulate construction site activities are the ___ and the Environmental Protection Agency (EPA).

Short Answer

1. What is the difference between a sketch and a drawing?

2. Where is the title block located on a print and on a working drawing?

3. What are the advantages of using print conventions?

4. What is dimensioning?

5. What is estimating as applied to a construction project?

Identification

Utility Plans

Identify the utilities shown on the plan.

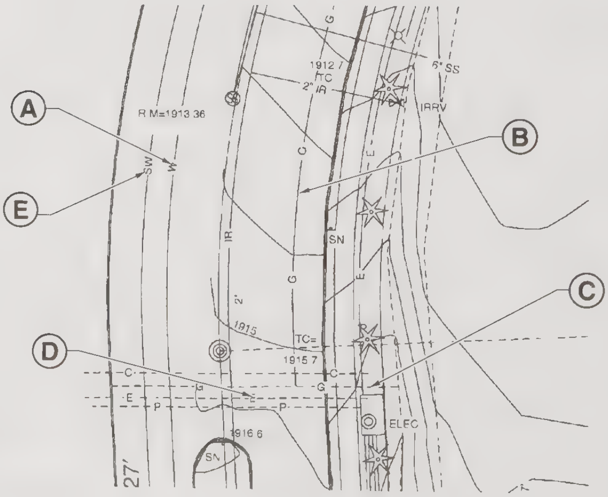
______________________ **1.** Electrical service

______________________ **2.** Natural gas main

______________________ **3.** Storm sewer

______________________ **4.** Water main

______________________ **5.** Wire leads (exposed above ground)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Section Line Types

Identify the section line types.

______________ **1.** Aluminum

______________ **2.** Brass

______________ **3.** Cast iron

______________ **4.** Concrete

______________ **5.** Earth

______________ **6.** Electrical insulation

______________ **7.** Electrical windings

______________ **8.** Fabric

______________ **9.** Glass

______________ **10.** Refractory metal

______________ **11.** Rock

______________ **12.** Sand

______________ **13.** Sound insulation

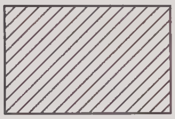
______________ **14.** Steel

______________ **15.** Thermal insulation

______________ **16.** Water

______________ **17.** Wood

______________ **18.** Zinc alloy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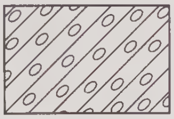
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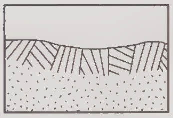
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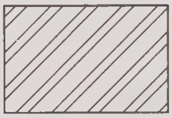
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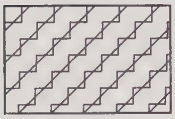
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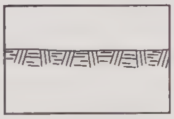
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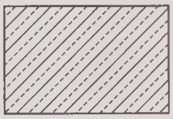
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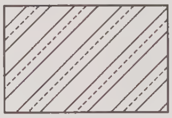
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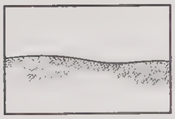
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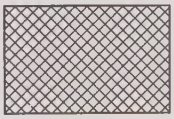
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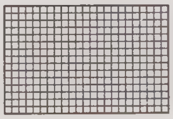
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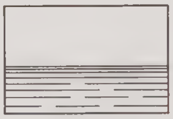
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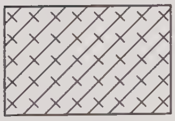
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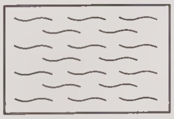
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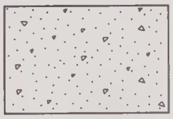
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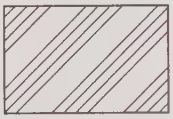
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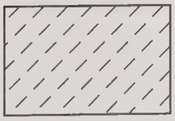
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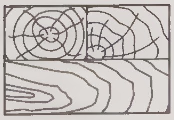
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Print Abbreviations and Symbols

Identify the print abbreviations and symbols.

______ **1.** Access hole

______ **2.** Building line

______ **3.** Bush

______ **4.** Centerline

______ **5.** Counterbore

______ **6.** Countersink

______ **7.** Depth

______ **8.** Diameter

______ **9.** Electric service

______ **10.** Existing elevation

______ **11.** Fence

______ **12.** Finish grade

______ **13.** Fire hydrant

______ **14.** Hedge row

______ **15.** Improved road

______ **16.** Light standard

______ **17.** Mailbox

______ **18.** Natural gas line

______ **19.** Natural grade

______ **20.** North

______ **21.** Point of beginning

______ **22.** Power pole and guy

______ **23.** Property line

______ **24.** Radius

______ **25.** Repetitive feature

______ **26.** Spherical diameter

______ **27.** Spherical radius

______ **28.** Street sign

______ **29.** Telephone line

______ **30.** Township line

______ **31.** Traffic signal

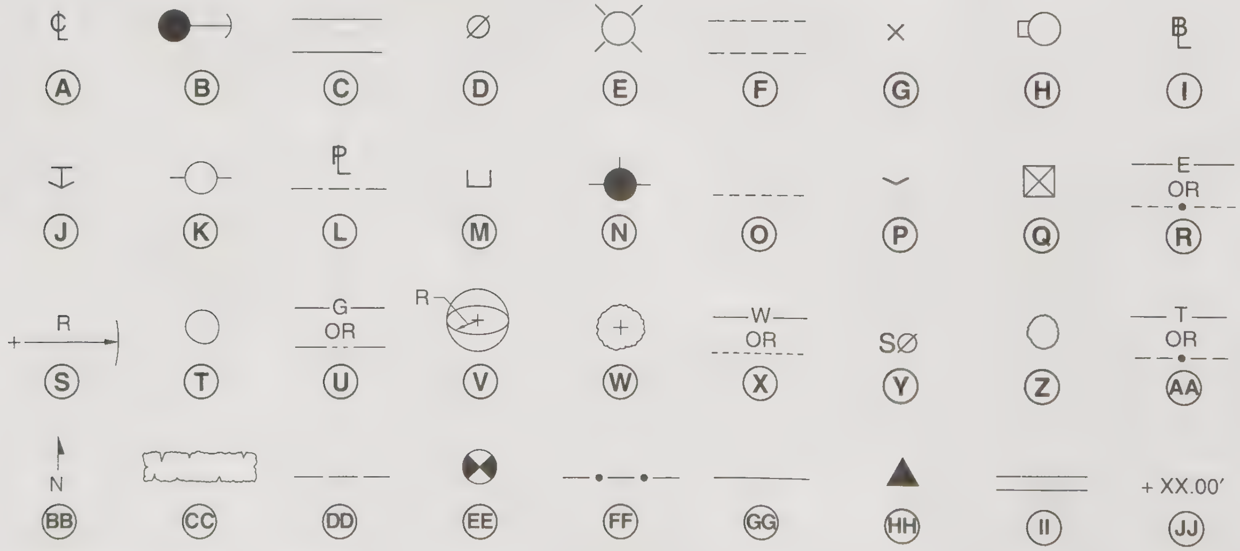
______ **32.** Tree

______ **33.** Unimproved road

______ **34.** Utility meter

______ **35.** Walk

______ **36.** Water line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Project Planning

8

Activities

Name ____ Date ______________________

Activity 8-1: Facility Planning

1. Develop a plan for an agricultural facility such as an equipment storage building, a pole barn, a cattle barn, or a similar structure. Prepare a detailed analysis of current and future requirements such as traffic flow, rainwater drainage, and accessibility. Make a list of anticipated improvements that would be required for future requirements.

Activity 8-2: Computations, Measurements, and Applications

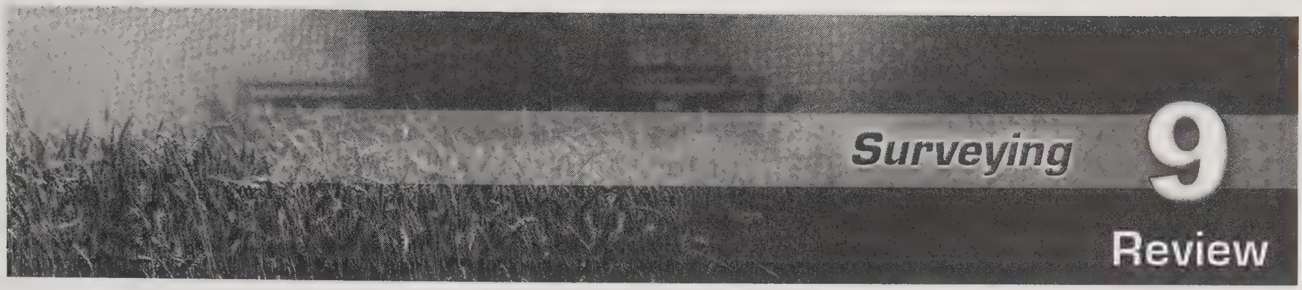
Answer the following questions.

__________________ **1.** The grade figure on a benchmark is established as 100.00′. The finish floor, which is 48′-0″ away, is given as 106.4′. What is the distance of the finish floor above the benchmark?

__________________ **2.** A set of plans is drawn at a scale of ¼″ = 1′-0″. The South wall is drawn 7½″ long. What is the length of the South wall?

__________________ **3.** A farmer pays $37,039.20 for a rural lot that measures 122′ wide and 184′ deep. What is the land cost per square foot?

__________________ **4.** A set of prints shows that a 24′-0″ × 36′-0″ area must be excavated to a depth of 10′-0″ for a basement. How many cubic yards of earth will be removed?



Surveying 9

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** The most common type of survey system used by professional land surveyors is the metes and bounds system.

T F **2.** The Public Land Survey System (PLSS) is a survey system that uses standard parallels and guide meridians to create identifiable townships and sections.

T F **3.** Because the Earth is round, the guide meridians follow the latitude lines and converge at the North Pole.

T F **4.** The platting process normally includes building access roads and, usually, installation of municipal and regulated utilities to serve the platted properties.

T F **5.** A witness point is a horizontal direction from one point to another with respect to true north on a plat of survey.

T F **6.** Plot plans are not necessary when the property owner proposes improvements, such as a building, and a building permit is required.

T F **7.** All property improvement locations are based on the established property corners and calculated perpendicular distances to the nearest property lines.

T F **8.** Generally, three technicians are required to properly perform survey work.

T F **9.** Grade elevations are based on the National Elevation Dataset (NED) from the U.S. Geological Survey (USGS) datum, which is the customary data referenced for survey work.

T F **10.** A laser level is a measuring device made of wood, plastic, or aluminum rod stock that has been specifically designed for use with a leveling instrument.

T F **11.** The leveling operation provides the elevation of the benchmark.

T F **12.** A builder's level is never mounted on a tripod.

T F **13.** A builder's level is used to focus on a small target and the field of vision is limited.

T F **14.** Transit elevation is determined from a benchmark.

T F **15.** The vernier scale on a transit-level must be set to 10°.

T F **16.** A right (90°) angle is the angle used most often in construction.

T F **17.** One of the first stages of a construction project is the construction of a building's foundation.

T F **18.** An offset is a line perpendicular at a known distance to the object line.

T F **19.** A laser target improves the distance and accuracy of a measurement.

T F **20.** The two types of laser levels most frequently used for most surveying applications are rotating laser levels and split-beam transit levels.

T F **21.** Lasers are generally divided into six basic classifications based on potential risk.

T F **22.** Laser levels must be operated only by persons trained in the proper installation, adjustment, and operation of laser instruments.

T F **23.** Direction measurements are made between a known point and an existing or proposed point to establish the space between two points or the size of objects.

T F **24.** A Geographic Information System (GIS) is an atmospheric positioning system that uses the location of navigational satellites orbiting the earth to determine the location and elevation of a GPS receiver.

T F **25.** GPS units (receivers) can determine real-time locations while the units are in motion without being affected by the weather.

Multiple Choice

______________ **1.** ___ is the process of measuring land by recording elevations, directions, and lengths of property lines and sizes of structures.

A. Surveying
B. Leveling
C. Platting
D. Dividing

______________ **2.** A(n) ___ point is the reference point for surveying using the PLSS.

A. witness
B. beginning
C. initial
D. guiding

______________ **3.** A(n) ___ is an imaginary north-south continuous line on the surface of the earth that is roughly parallel to the principle meridian and used to establish longitude.

A. longitudinal line
B. standard parallel
C. guide meridian
D. equator

________________ **4.** A ___ is a square tract of land measuring 1 mile (1.61 km) on each side and contains 640 acres (259 ha).

A. subdivision
B. quadrangle
C. township
D. section

________________ **5.** ___ is a process regulated by state statute to record the division of land.

A. Platting
B. Plotting
C. Surveying
D. Bearing

________________ **6.** A(n) ___ point is a natural physical feature, such as a tree, that is marked and recorded in the original survey notes with a measured distance and direction to the section corner.

A. guiding
B. witness
C. beginning
D. initial

________________ **7.** Laser levels are self-leveling and accurate up to ___′.

A. 250
B. 500
C. 1000
D. 1500

________________ **8.** Leveling rods used in surveying have ___ type(s) of graduations.

A. one
B. two
C. three
D. four

________________ **9.** ___ are available with 12- to 32-power telescopes.

A. Automatic levels
B. Transit-levels
C. Builder's levels
D. all of the above

________________ **10.** Angles of ___° or less can be measured directly with the horizontal circle scale on a transit-level without any addition or subtraction.

A. 45
B. 90
C. 120
D. 180

_______________ **11.** A ___ is a handheld measuring device that uses a standard laser beam that reflects off of its target and provides a distance measurement.

A. leveling rod
B. laser target
C. plumb bob
D. laser measuring meter

_______________ **12.** The laser beam of a rotating laser level moves ___° in a continuous, level motion.

A. 15
B. 90
C. 180
D. 360

_______________ **13.** Class ___ includes low-power visible laser beams that normally do not present a potential hazard if viewed for short periods of time.

A. I
B. II
C. III
D. IV

_______________ **14.** A ___ is a measuring tool consisting of a long continuous strip of fabric, plastic, or steel that is graduated in regular increments of length measurements.

A. leveling rod
B. distance measuring wheel
C. tape rule
D. framing square

_______________ **15.** Precision farming with GPS/GIS based systems is used for ___, seed rate applications, fertilizer spreading, and harvest yield mapping.

A. field mapping
B. farm planning
C. tractor guidance
D. all of the above

Completion

_______________ **1.** ___ is a survey system that measures and identifies land by describing property boundaries with distances and directions referencing natural and man-made physical features as boundary markers.

_______________ **2.** A(n) ___ is a map drawn to scale that shows the division of land, shows the distance and bearing between property corners, and provides a legal description of the property.

_______________ **3.** A(n) ___ is a square tract of land measuring 6 miles (9.65 km) on each side and is identified by its location in the tier and the range of a quadrangle.

________________ **4.** A(n) ___ is the starting point for a survey that must be directly located by both distance and direction to a point established in the original section survey or recorded plat of subdivision.

________________ **5.** A dust cap to protect the ___ of a telescope when it is not in use is usually included with the instrument.

________________ **6.** Most builder's levels have a horizontal ___ screw to hold the instrument in a fixed horizontal position.

________________ **7.** A horizontal ___ screw allows precise adjustment of the telescope on a builder's level in a left or right horizontal direction.

________________ **8.** Although they can be used for most types of laser level applications, ___ laser levels are primarily used for plumbing and leveling operations.

________________ **9.** ___ is the process of determining the difference in elevation between points.

________________ **10.** A(n) ___ is used with a builder's level when the instrument must be set up over a specific point.

________________ **11.** When placing a tripod in the desired position, extend the legs and spread them about ___′ apart.

________________ **12.** The ___ of a builder's level rotates on top of the circular base.

________________ **13.** A(n) ___ is a stable reference point marked with the elevation above mean sea level from which differences in elevation around the work area are measured.

________________ **14.** A(n) ___ is used to lay out points by calculating (turning) known angles from known points.

________________ **15.** A tripod set on soft or marshy soil may require a base of three ___ driven into the ground.

________________ **16.** A(n) ___ level is a leveling device that projects a concentrated beam of light horizontally or vertically from a source, and the beam of light is then used as a reference for leveling or verifying horizontal or vertical alignment.

________________ **17.** A(n) ___ level generates two laser beams, which are projected 90° to one another.

________________ **18.** Many lasers used for construction are Class ___ lasers.

________________ **19.** A(n) ___ is a wheeled, walk-behind device that is used to record measurements over distances.

________________ **20.** A(n) ___ is a system that collects, stores, and manages geographic reference information.

Short Answer

1. What is a “direction,” as listed on a plat of survey?

2. List the basic equipment used with leveling instruments.

3. What is a laser target?

4. List three factors that must be considered when selecting a laser level.

5. What does an agricultural GPS include?

Identification

Builder’s Levels

Identify the builder’s level components.

______________ **1.** Eyepiece

______________ **2.** Focusing knob

______________ **3.** Horizontal clamp screw

______________ **4.** Horizontal graduated circle

______________ **5.** Horizontal tangent screw

______________ **6.** Leveling screw

______________ **7.** Leveling vial

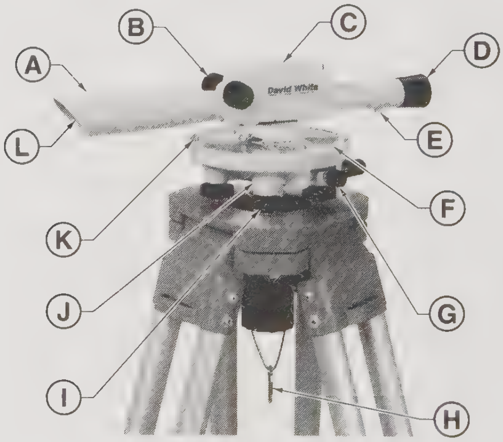
______________ **8.** Objective lens

______________ **9.** Plumb bob hook

______________ **10.** Pointer

______________ **11.** Telescope

______________ **12.** Tripod mounting stud



David White Instruments

Tripods

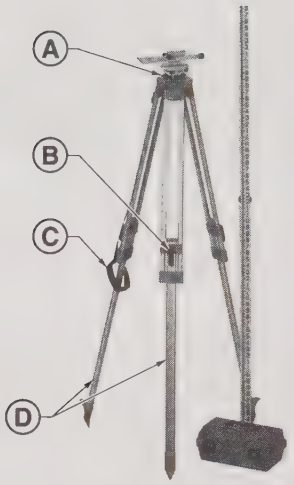
Identify the tripod components.

_______________ **1.** Legs

_______________ **2.** Locking lever

_______________ **3.** Sling strap

_______________ **4.** Tripod head



David White Instruments

Transit-Levels

Identify the transit-level components.

_______________ **1.** Eyepiece

_______________ **2.** Focusing knob

_______________ **3.** Horizontal circle

_______________ **4.** Horizontal clamp

_______________ **5.** Horizontal tangent screw

_______________ **6.** Horizontal vernier scale

_______________ **7.** Leveling vial

_______________ **8.** Plumb bob hook

_______________ **9.** Telescope

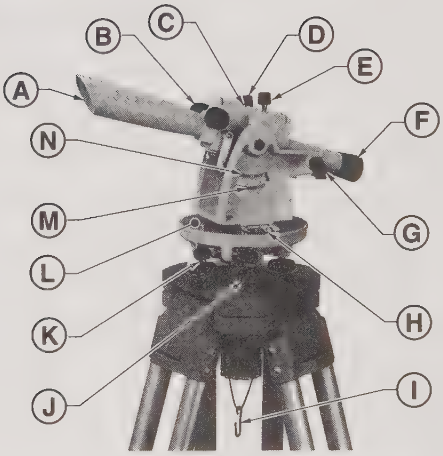
_______________ **10.** Telescope lock lever

_______________ **11.** Vertical arc

_______________ **12.** Vertical arc pointer

_______________ **13.** Vertical clamp screw

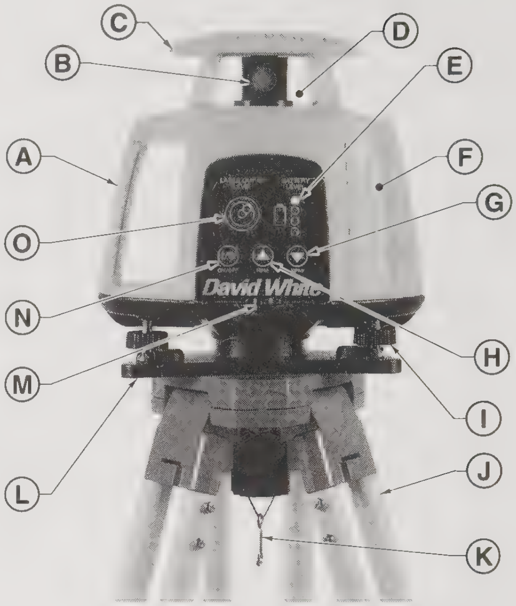
_______________ **14.** Vertical tangent screw



David White Instruments

Laser Levels

Identify the laser level components.



David White Instruments

______________ **1.** Base

______________ **2.** Battery housing

______________ **3.** Battery life indicator

______________ **4.** Beacon cover

______________ **5.** Beacon protector

______________ **6.** Beacon speed decrease control

______________ **7.** Beacon speed increase control

______________ **8.** Handle

______________ **9.** Leveling bubble

______________ **10.** Leveling screw

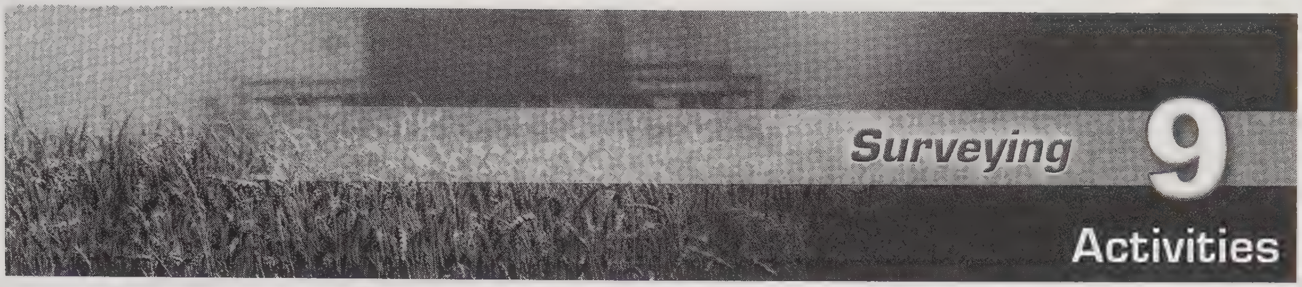
______________ **11.** ON/OFF switch

______________ **12.** Out-of-level indicator

______________ **13.** Plumb bob hook

______________ **14.** Rotating beacon

______________ **15.** Tripod



Surveying 9

Activities

Name ______________________________ Date ________________

Activity 9-1: Property Line Calculations

Bearings are shown along survey lines, property lines, and points of interest. Letters denoting direction and angle measurements are shown along property lines to indicate their bearing. The primary direction of a property line is indicated first as either north (N) or south (S). The letter is followed by a compass reading not exceeding 90° that indicates the angle between the property line and the north-south reference line. The secondary direction follows the compass reading in the direction that the angle was measured and is either east (E) or west (W). For example, a reading of N 7°-45′-0″ E indicates a property line that forms an angle of seven degrees, forty-five minutes, and zero seconds to the east of the north-south reference line, headed in a northerly direction. Property line calculations can be added together or subtracted from one another.

Examples:

17°-32′ + 15°-12′
= (17° + 15°) + (32′+ 12′)
= 32°-44′

270° – 90°-30′
= 270 – (90 + (30 ÷ 60)
= 270 – (90.5)
= 179°-30′

Perform the following property line calculations.

________________ **1.** 6°-12′ + 15°-32′ = ___

________________ **2.** 120° + 17°-58′ = ___

________________ **3.** 90° + 15°-7′-35″ = ___

________________ **4.** 60°-3′-38″ + 15°-12′ = ___

________________ **5.** 180°-19′-16″ + 12°-30′-24″ = ___

________________ **6.** 145° – 32′-38″ = ___

________________ **7.** 96°-52′ – 35′-20″ = ___

________________ **8.** 270° – 90°-45′ = ___

__________ **9.** 58′-40″ – 16′-31″ = ___

__________ **10.** 45° – 38°-35′ = ___

__________ **11.** 17°-32′ + 91°-15′-30″ = ___

__________ **12.** 112°-20′-35″ + 9°-15′-35″ = ___

__________ **13.** 150° – 45°-44′ = ___

__________ **14.** 88°-28′ – 60°-15′-45″ = ___

__________ **15.** 36°-37′-45″ + 52′ = ___

__________ **16.** 245° + 15° + 38°-12′ = ___

__________ **17.** 45′-50″ – 30′-20″ = ___

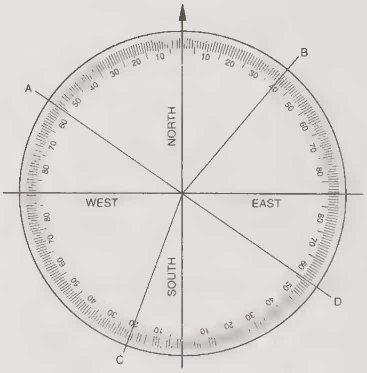
__________ **18.** 130°-15′ – 45°-40′ = ___

__________ **19.** 120°-40′-30″ – 90°-55′ = ___

__________ **20.** 180° + 70° + 55°-15′ = ___

Activity 9-2: Compass Readings

Provide the compass readings for NW, NE, SW, and SE diagonals.

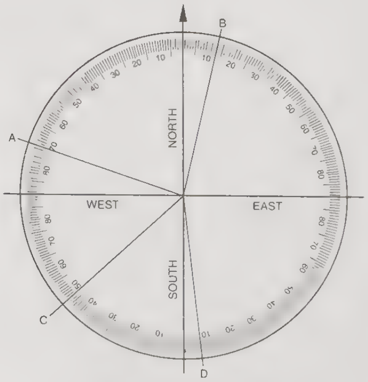

A
B
C
D
NORTH
SOUTH
EAST
WEST
10
20
30
40
50
60
70
80

__________ **1.** A = ___°

__________ **2.** B = ___°

__________ **3.** C = ___°

__________ **4.** D = ___°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NORTH
SOUTH
EAST
WEST
10
20
30
40
50
60
70
80

__________ **5.** A = ___°

__________ **6.** B = ___°

__________ **7.** C = ___°

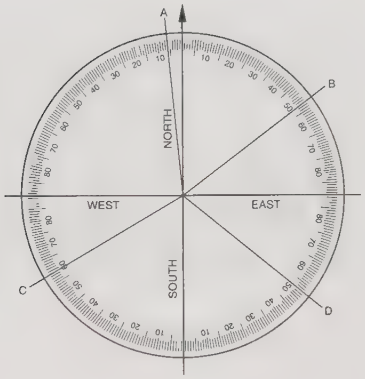
__________ **8.** D = ___°

______________________ **9.** A = ___°

______________________ **10.** B = ___°

______________________ **11.** C = ___°

______________________ **12.** D = ___°

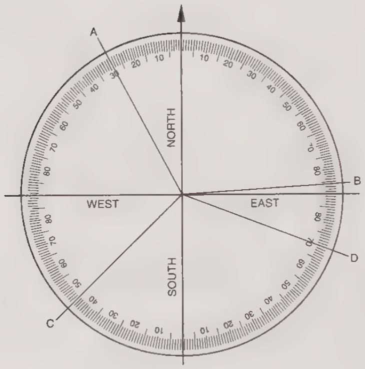

A
B
C
D
NORTH
SOUTH
EAST
WEST

______________________ **13.** A = ___°

______________________ **14.** B = ___°

______________________ **15.** C = ___°

______________________ **16.** D = ___°


A
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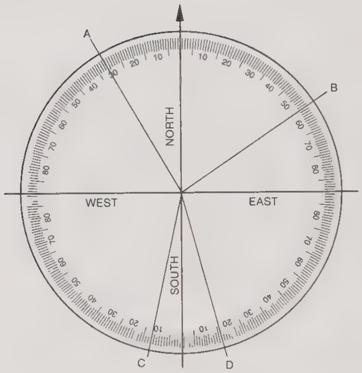
EAST
WEST

______________________ **17.** A = ___°

______________________ **18.** B = ___°

______________________ **19.** C = ___°

______________________ **20.** D = ___°


A
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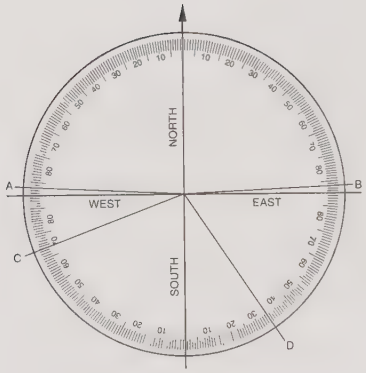
EAST
WEST

______________________ **21.** A = ___°

______________________ **22.** B = ___°

______________________ **23.** C = ___°

______________________ **24.** D = ___°


A
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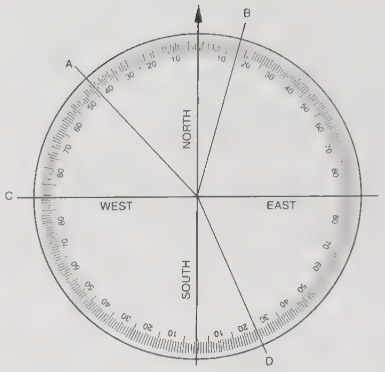
WEST

____________________ **25.** A = ___°

____________________ **26.** B = ___°

____________________ **27.** C = ___°

____________________ **28.** D = ___°


A
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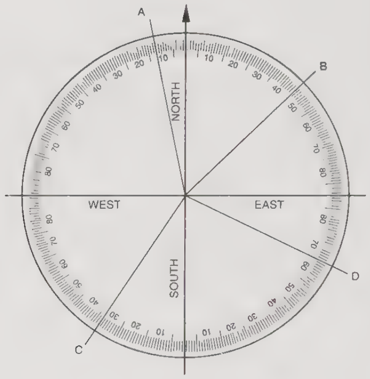
SOUTH
WEST
EAST

____________________ **29.** A = ___°

____________________ **30.** B = ___°

____________________ **31.** C = ___°

____________________ **32.** D = ___°


A
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NORTH
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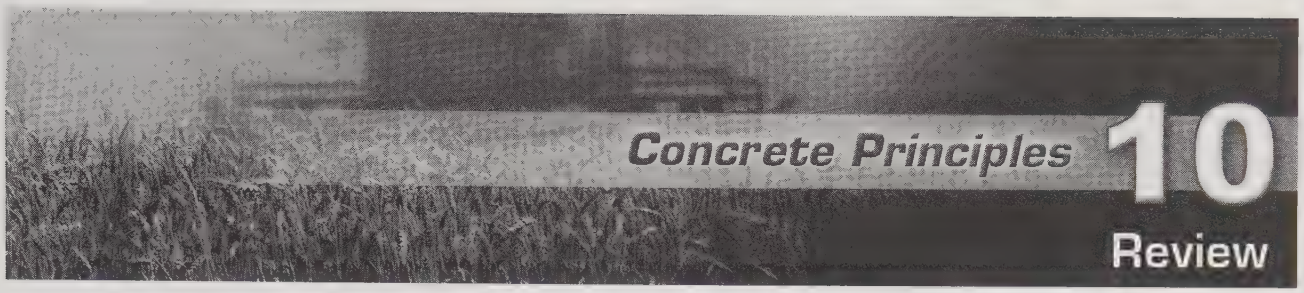


Concrete Principles 10

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** Concrete is comprised of only two primary components, (cement and water), in varying proportions.

T F **2.** The percentages of cement, aggregate, and water used in any concrete mix vary according to the characteristics required for a particular application and concrete material conditions.

T F **3.** Water makes up the largest volume (60% to 75%) of material used in concrete.

T F **4.** The amount of aggregate in the concrete mixture is the primary factor in determining concrete quality and strength.

T F **5.** In order for hydration to occur, the water used for concrete must have a pH of 6 to 8.

T F **6.** During hydration, the water in the concrete mixture evaporates.

T F **7.** Tensile members used in concrete include steel rods, bars, and fibers; metal wire; and plastic and glass fibers.

T F **8.** Rolls of welded wire reinforcement for concrete are stretched out and set in place to reinforce slabs such as sidewalks.

T F **9.** The aspect ratio is used to represent the fiber surface area that comes into contact with the concrete in fiber-reinforced concrete.

T F **10.** Concrete can be formed into only one shape.

T F **11.** Bleedwater is excess water that collects on the surface of concrete as aggregate material sinks in the concrete mixture.

T F **12.** Shoring is done with an up-and-down motion.

T F **13.** Placing tools reduce the difficulty of placing the exact amount of concrete from a ready-mix truck to the proper area.

T F **14.** Rodding is the process of leveling fresh concrete by moving a straightedge back and forth across it.

T F **15.** Concrete finishing tools include floats, trowels, power trowels, edgers, and groovers.

T F **16.** A concrete detailing tool is any tool used to place a final texture or design on the surface of concrete.

T F **17.** A rebar cutter is a tool used to cut rebar to required length.

T F **18.** Wire is used as a guide to ensure straightness when setting forms for concrete placement.

T F **19.** Soil is classified as granular or cohesive based on sieve analysis.

T F **20.** Soil compaction equipment is selected by considering soil type (granular, cohesive, or mixed), job-site conditions, and soil compaction specifications.

T F **21.** Groundwork must be completed before concrete construction can begin, although additional grading and backfilling are often required after the work has been completed.

T F **22.** Trenching is the process of removing earth in order to form a cavity, trench, or depression.

T F **23.** Excavation methods used to prevent collapse when working below grade level include sloping, benching, and shoring.

T F **24.** Backfilling is the use of wood or metal members to temporarily support soil, formwork, or construction materials.

T F **25.** Gravel is typically used as backfill, since it allows good water drainage around structures.

Multiple Choice

__________ **1.** ___ is a mixture of cement, aggregate, and water.
A. Soil
B. Concrete
C. Sand
D. none of the above

__________ **2.** ___ is a mixture of cement and water that acts as a bonding agent in concrete.
A. Caulk
B. Mastic
C. Cement paste
D. Rubber cement

__________ **3.** Hydration is a chemical reaction between ___ and water that bonds molecules, resulting in hardening of the mixture.
A. cement
B. soil
C. aggregate
D. sand

_______________ **4.** ___ is the maintenance of the proper moisture content and temperature in concrete during its early stages to obtain specific properties.

A. Backfilling
B. Rodding
C. Shoring
D. Curing

_______________ **5.** Common admixtures include ___, accelerators, and air-entrainers.

A. water reducers
B. superplasticizers
C. retarders
D. all of the above

_______________ **6.** ___ concrete is concrete that has had tensile members placed in it to increase its tensile strength.

A. Air-entrained
B. Reinforced
C. Refractory
D. Rapid strength

_______________ **7.** Grade 40 axle steel has an ultimate strength of ___ psi.

A. 40,000
B. 50,000
C. 70,000
D. 90,000

_______________ **8.** Number 8 size rebar has a weight of ___ lb per foot.

A. 2.670
B. 3.400
C. 4.303
D. 5.313

_______________ **9.** ___ is the ability of concrete, in its plastic form, to flow as it is being placed into a form.

A. Elasticity
B. Vibration
C. Hydration
D. Consistency

_______________ **10.** A ___ is a hand tool consisting of a flat piece of metal with corrugated teeth on one edge.

A. tamper
B. straightedge
C. spreader
D. rake

_______________ **11.** A ___ is a hand tool with a flat or slightly rounded plate that is used to smooth the surface of fresh concrete before it is troweled.

A. float
B. rake
C. edger
D. groover

______________ **12.** ___ are used to produce a rough, skid-resistant texture on concrete surfaces.
A. Floor scrapers
B. Finishing brooms
C. Safety rollers
D. Rakes

______________ **13.** A ___ is a tool with a wide rubber blade used to remove bleedwater or rainwater from concrete.
A. knee board
B. floor squeegee
C. rebar cutter
D. finishing broom

______________ **14.** ___ force compaction is soil compaction using a machine that delivers a rapid succession of blows to the soil.
A. Vibration
B. Impact
C. Static
D. Rolling

______________ **15.** ___ is an excavation method that uses a series of steps carved into the earth walls around the excavation site to prevent collapse.
A. Benching
B. Shoring
C. Rodding
D. Backfilling

Completion

______________ **1.** ___ is a mixture of shells, limestone, clay, silica, marble, shale, sand, bauxite, and iron ore that is ground, blended, fused, and crushed to a powder.

______________ **2.** ___ aggregate is aggregate that has absorbed the maximum amount of moisture with no excess moisture on the outside.

______________ **3.** ___ is a ground and calcined (heated) mixture of limestone, shells, cement rock, silica sand, clay, shale, iron ore, gypsum, and clinker.

______________ **4.** The ratio of pounds of water to pounds of cement per unit of concrete is the ___ ratio.

______________ **5.** ___ is a condition that occurs when aggregate settles because the mixture is too thin to support it.

______________ **6.** A(n) ___ is a substance other than water, aggregate, or portland cement added to modify the properties of concrete.

______________ **7.** ___ is steel bar containing lugs (protrusions) that allow it to interlock with concrete.

______________ **8.** ___ is heavy-gauge wire joined in a grid and used to reinforce and increase the tensile strength of concrete.

________________ **9.** A(n) ___ ratio is the fiber length divided by its diameter.

________________ **10.** A(n) ___ is a cone made of galvanized metal that is 8″ in diameter at the bottom, 4″ in diameter at the top, 12″ high, and used to perform slump tests.

________________ **11.** A(n) ___ is a hand tool with a long handle and a steel grill base used for compacting fresh concrete, forcing coarse aggregate below the surface, and bringing cement paste to the surface for finishing.

________________ **12.** A(n) ___ is a piece of concrete finishing equipment in which a series of blades are rotated by an internal combustion engine.

________________ **13.** A(n) ___ is a hand tool used to produce a finished radius along the edge of a concrete slab.

________________ **14.** A(n) ___ is a detailing tool consisting of a molded pattern that provides a finished texture to concrete.

________________ **15.** A(n) ___ is a tool with a hardened edge used for scraping surfaces clean.

________________ **16.** A(n) ___ soil is soil that remains in a compacted state after a weight is removed.

________________ **17.** ___ compaction is soil compaction that uses weight from a heavy machine to squeeze soil particles together without vibratory influence.

________________ **18.** ___ is the preliminary grading, excavating, and backfilling of earth required at a job site.

________________ **19.** ___ is the process of lowering high spots and filling in low spots of earth to make the shape conform to the job requirements.

________________ **20.** ___ is the replacing of soil in trenches and excavations after work is complete.

Short Answer

1. What is aggregate?

2. List the three most commonly used steel reinforcing members.

3. List the three classifications of concrete hand tools.

4. What is soil compaction?

5. What is sloping?

Identification

Concrete Placing Tools

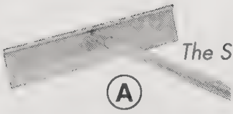
Identify the concrete placing tools.

__________ **1.** Rake

__________ **2.** Spreader

__________ **3.** Tamper

__________ **4.** Straightedge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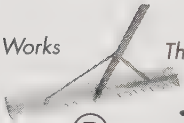
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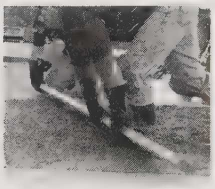
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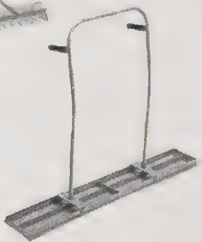
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Concrete Equipment

Identify the concrete equipment.

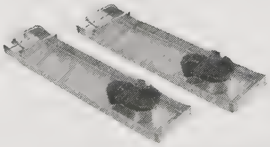
__________ **1.** Floor scraper

__________ **2.** Floor squeegee

__________ **3.** Knee boards

__________ **4.** Nylon line

__________ **5.** Rebar and bolt cutter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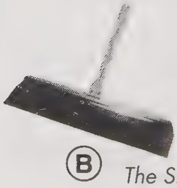
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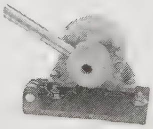
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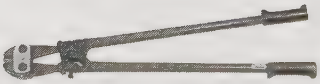
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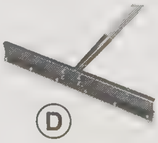
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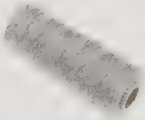

Ⓔ The Stanley Works

Concrete Finishing Tools

Identify the concrete finishing tools.

______ **1.** Bull float

______ **2.** Bull float attachment

______ **3.** Channel float

______ **4.** Darby float

______ **5.** Fresno trowel

______ **6.** Fresno trowel attachment

______ **7.** Hand float

______ **8.** Hand groover

______ **9.** Round-ended trowel

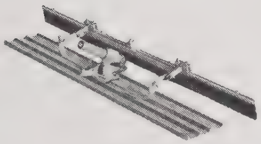
______ **10.** Round-square-ended trowel

______ **11.** Sidewalk edger

______ **12.** Square-ended trowel

______ **13.** Walking edger

______ **14.** Walking groover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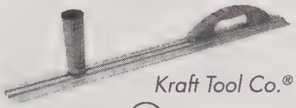
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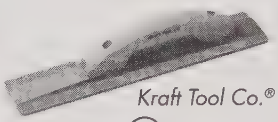
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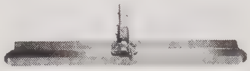
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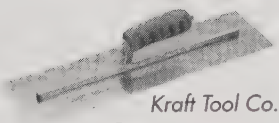
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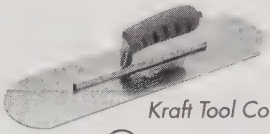
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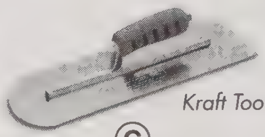
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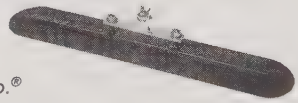
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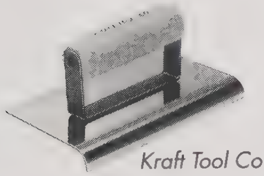
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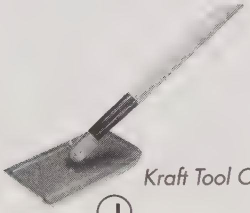
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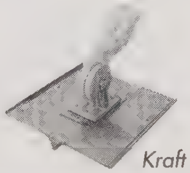
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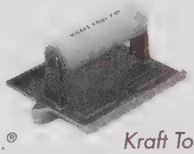
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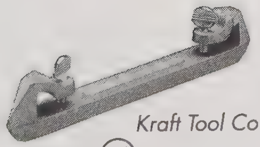
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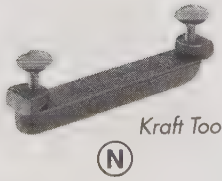
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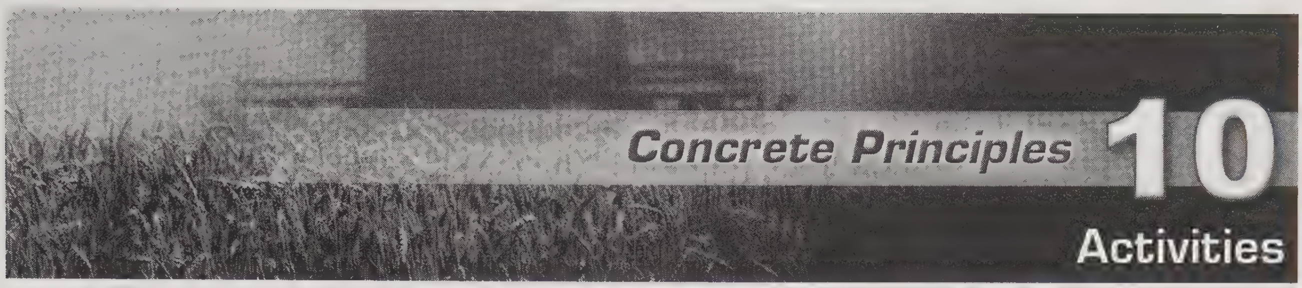


Concrete Principles 10

Activities

Name ______________________________ **Date** ____________________

Activity 10-1: Admixture Applications

A variety of admixtures can be added to a concrete mix to enhance certain concrete characteristics, such as strength, cure time, and appearance.

Match the admixture type with the admixture purpose.

Admixture Type

____________ **1.** Water reducer

____________ **2.** Superplasticizer

____________ **3.** Retarder

____________ **4.** Accelerator

____________ **5.** Air-entraining admixture

____________ **6.** Bonding aid

Admixture Purpose

A. Helps cement paste stick to aggregate and improve the adherence of fresh concrete to hardened concrete

B. Shortens set time and increases early strength

C. Increases concrete strength and workability and reduces cement content and hydration heat

D. Delays the setting and hardening of concrete

E. Adds microscopic air bubbles to concrete

F. Provides high initial slump without lowering concrete strength, increasing waiting time for finishing, or segregating the concrete mixture

Activity 10-2: Trench Sloping

Per OSHA standards, trenches dug in different types of soil require different slopes to ensure worker safety. Trenches dug in highly cohesive soil must be sloped 53°, trenches in cohesive soil must be sloped 45°, and trenches in granular soil must be sloped 34°. The approximate slope can be calculated by multiplying the depth of the trench by the cotangent of the slope angle. The cotangent of 53° is 0.7265, the cotangent of 45° is 1.0, and the cotangent of 34° is 1.4826. For example, the cutback distance of a 6′ deep trench dug in highly cohesive soil (53° slope) is 4.36′ (6′ × 0.7265 = 4.36′).

Determine the cutback distances of the following trenches.

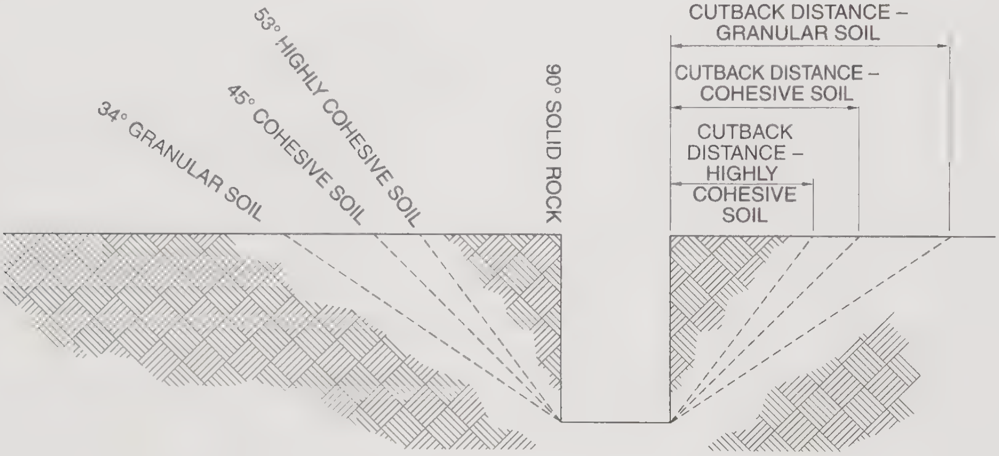
__________________ **1.** 6′ deep trench in cohesive soil

__________________ **2.** 6′ deep trench in granular soil

__________________ **3.** 10′ deep trench in highly cohesive soil

__________________ **4.** 8′ deep trench in granular soil

__________________ **5.** 12′ deep trench in cohesive soil


53° HIGHLY COHESIVE SOIL
45° COHESIVE SOIL
34° GRANULAR SOIL
90° SOLID ROCK
CUTBACK DISTANCE – GRANULAR SOIL
CUTBACK DISTANCE – COHESIVE SOIL
CUTBACK DISTANCE – HIGHLY COHESIVE SOIL

Activity 10-3: Compressive Strength

Compressive strength is the measured maximum resistance of concrete to axial loading, which is typically expressed in pounds per square inch (psi). Compressive strength is calculated using the pressure gauge reading from a hydraulic press used to perform the compression test and the cross-sectional area of the compression test specimen. Compressive strength can be calculated by using the following formula:

$$f_c' = \frac{f_f}{A}$$

where
f_c' = compressive strength (in psi)
f_f = pressure gauge reading at failure (in lb)
A = cross-sectional area of specimen (in sq in.)

Example: Determine the compressive strength of a concrete specimen measuring 6″ in diameter that breaks with a gauge reading of 125,000 lb.

1. Determine cross-sectional area. Cross-sectional area is determined by applying the formula:

   $A = 0.7854d^2$
   where
   A = area (in sq in.)
   0.7854 = constant
   d = diameter (in in.)

   $A = 0.7854d^2$
   $A = 0.7854 \times (6 \times 6)$
   $A = 0.7854 \times 36$
   $A = 28.27$ sq in.

2. Determine compressive strength.

$$f_c' = \frac{f_f}{A}$$

$$f_c' = \frac{125{,}000}{28.27}$$

$$f_c' = \mathbf{4421.6\ psi}$$

Determine the compressive strength of the following compression test specimens.

________________ **1.** Pressure gauge reading at failure = 145,000 lb; specimen = 6″ diameter

________________ **2.** Pressure gauge reading at failure = 157,000 lb; specimen = 6″ diameter

________________ **3.** Pressure gauge reading at failure = 225,000 lb; specimen = 8″ diameter

________________ **4.** Pressure gauge reading at failure = 250,000 lb; specimen = 8″ diameter

________________ **5.** Pressure gauge reading at failure = 445,000 lb; specimen = 12″ diameter

Activity 10-4: Manufacturer and Trade Organization Research

1. Refer to cement and admixture manufacturer websites to request literature regarding their products. Review the product literature and identify characteristics of and applications for each product.

2. Research concrete construction trade associations by visiting their websites or by requesting print literature from the associations. Identify and list each association's purpose and benefits of membership.

Concrete Placement and Finishing

11

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** The most visible part of any foundation is the floor slab, which forms the perimeter of the structure.

T F **2.** Foundation design is determined by the foundation weight, imposed load of the building's superstructure, and load-bearing capacity of the soil.

T F **3.** A commonly used design for a slab-on-grade foundation is a monolithically placed floor slab and foundation.

T F **4.** A joint is formed by nailing wood members or plastic foam panels equal to the depth and width of the shoulder to the top of the inside wall form.

T F **5.** A footing should never be less than 7″ thick, and the footing should be at least one-half the wall thickness on each side of the foundation wall.

T F **6.** Common footings are pier footings and expansion footings.

T F **7.** Construction joints are used where fresh concrete butts against the edge of a section of concrete that is set.

T F **8.** Ground-supported slabs are commonly placed for ground-level floors of residential, agricultural, and commercial buildings that do not have basements.

T F **9.** Moisture conditions are never considered in the construction of ground-supported slabs.

T F **10.** Vapor barriers are used to contain ground moisture beneath the slab.

T F **11.** Troweling may be accomplished by striking off a concrete surface using guides and a straightedge or using a vibratory truss screed.

T F **12.** Cracks in concrete are caused by expansion and contraction of concrete, bending of building components, settling, construction stresses, and corrosion of steel members embedded in concrete.

T F **13.** A control joint is a joint that separates adjoining sections of concrete to allow for movement caused by expansion and contraction of the slabs.

T F **14.** The only method of forming an expansion joint is to place a piece of preformed asphalt-impregnated material in the joint.

T F **15.** Fogging can be caused by dropping the mix from too great of a distance and should be avoided when transferring concrete from a truck to a chute, bucket, and buggy.

T F **16.** Concrete is placed and distributed in an even layer, rather than placed in piles and leveled off.

T F **17.** Common manual concrete floating techniques are darby, bull, and hand floating.

T F **18.** Darby floats are available in sizes from 14″ to 18″ in length and have from 1 to 3 handles.

T F **19.** Bull floats are easy to use on wide slabs because of their long handle and reach.

T F **20.** Bull floating is a floating operation that uses a hand float to fill in low spots and level down ridges left by screeding.

T F **21.** A second troweling consists of as many passes as necessary to remove all imperfections from the surface.

T F **22.** Edging is performed after screeding or tamping and again after finish troweling.

T F **23.** Edging begins before concrete stiffens.

T F **24.** The free-fall distance of concrete within a wall form should be limited to 4′ to 6′.

T F **25.** Concrete placed during hot weather is subject to excessive water evaporation.

Multiple Choice

__________ **1.** A commonly used slab-on-grade foundation design is a floor slab constructed independently of a ___ foundation.
- A. T-
- B. rectangular
- C. battered
- D. all of the above

__________ **2.** A ___ foundation is formed by constructing an edge form along the outside edge of a trench.
- A. below-grade
- B. monolithic slab-on-grade
- C. battered
- D. rectangular

__________ **3.** A ___ is the portion of a foundation that spreads and transmits loads directly to the soil.
- A. footing
- B. slab
- C. joint
- D. keyway

________________ **4.** Pier footings can be ___, stepped, or tapered.

A. triangular
B. square
C. octagonal
D. all of the above

________________ **5.** ___ is the construction of concrete slabs, walkways, and other flat, horizontal concrete surfaces.

A. Placement
B. Finishing
C. Flatwork
D. Groundwork

________________ **6.** A ___ is a designed crack in concrete used primarily to allow free movement of the slab, reduce stress, and reduce cracking.

A. footing
B. pier footing
C. joint
D. keyway

________________ **7.** A type of concrete joint is a ___ joint.

A. control
B. footing
C. pier
D. all of the above

________________ **8.** A(n) ___ joint is used where a bond is needed between two successive placements of concrete.

A. expansion
B. slab-on-grade
C. control
D. none of the above

________________ **9.** Concrete ___ is the transfer of concrete from a concrete truck or other transporting means into assembled concrete forms.

A. placement
B. finishing
C. jointing
D. none of the above

________________ **10.** Finishing procedures include ___.

A. pouring
B. forming
C. mixing
D. none of the above

______________ **11.** ___ is a finishing procedure that levels ridges left by screeding and fills small hollows in the surface of concrete.
A. Screeding
B. Troweling
C. Floating
D. Edging

______________ **12.** ___ floating prepares a freshly poured concrete surface for troweling.
A. Darby
B. Screed
C. Grade
D. all of the above

______________ **13.** ___ is a finishing procedure that rounds off the square edges of a slab.
A. Screeding
B. Edging
C. Floating
D. Troweling

______________ **14.** In the initial curing stage, the temperature of the concrete should be maintained at approximately ___°F, and the concrete should be kept thoroughly moist for a minimum of five to seven days.
A. 30
B. 70
C. 90
D. 180

______________ **15.** Concrete attains about 85% of its strength after ___ days.
A. 7
B. 21
C. 28
D. none of the above

Completion

______________ **1.** A(n) ___ is the part of a building that rests on and extends into the ground to provide support for a structure.

______________ **2.** A(n) ___ foundation is a cost-effective method that eliminates deep excavations, high foundation walls, and costly wood-floor systems.

______________ **3.** A(n) ___ is formed by the concrete placed between the edge form and the opposite wall of a trench.

______________ **4.** A(n) ___ is a groove formed in fresh concrete that interlocks concrete structures placed at different times.

______________ **5.** A(n) ___ footing is a foundation footing for a pier or column.

________________ **6.** A(n) ___ footing is a concrete form used to distribute the load of a column or wall to the subgrade.

________________ **7.** ___ is the lifting of a surface, such as concrete or pavement, as a result of freeze-thaw cycles occurring in the underlying soil.

________________ **8.** Form ___ is commonly established using a carpenter's level or transit-level.

________________ **9.** Frost lines are typically ___′ or more underground.

________________ **10.** A(n) ___ joint is a groove made in a horizontal or vertical concrete surface to create a weakened plane and control the location of cracking.

________________ **11.** ___ joints are used in slabs that cover large areas and where a great amount of expansion and contraction is expected.

________________ **12.** ___ is the separation of sand and cement from the coarse aggregate in a concrete mix.

________________ **13.** ___ are often used to consolidate concrete for slabs covering large areas.

________________ **14.** During initial curing, concrete shrinks an average of ⅔″ per ___′.

________________ **15.** A subgrade should be dampened to prevent the rapid loss of ___ from the freshly placed concrete.

________________ **16.** ___ is a concrete surface defect where the concrete appears as a wavy surface.

________________ **17.** A(n) ___ edger can be used after concrete has set sufficiently to perform final edging.

________________ **18.** A(n) ___ tool is often used to consolidate the concrete in small and low forms.

________________ **19.** ___ is the process of maintaining proper concrete moisture content and temperature long enough to allow hydration of the concrete and development of the desired properties.

________________ **20.** ___ is similar to spraying and produces a mist-like effect.

Short Answer

1. When are spread footings used?

2. What are the design and construction of ground-supported concrete slabs based on?

3. List the procedure used for site preparation for a concrete slab requiring fill and a gravel base course.

4. What is darby floating?

5. When can a second troweling pass required be performed?

Identification

Foundation Designs

Identify the foundation designs.

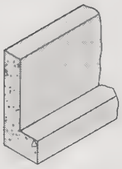
______________ **1.** Battered

______________ **2.** L-

______________ **3.** Rectangular

______________ **4.** Slab-on-grade

______________ **5.** T-



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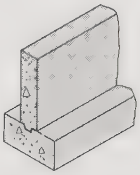

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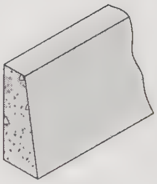

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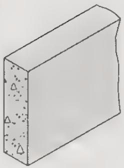

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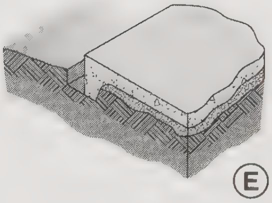

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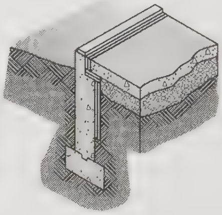


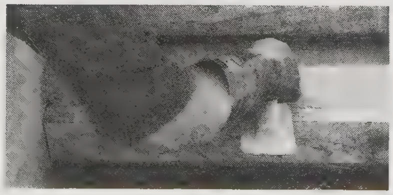
Floats

Identify the float types.

______________ **1.** Bull

______________ **2.** Darby

______________ **3.** Hand



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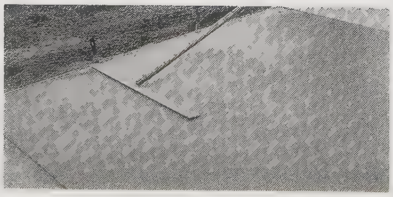

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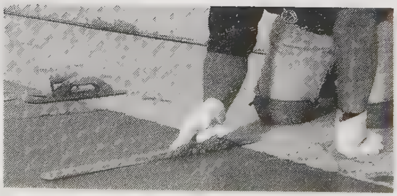

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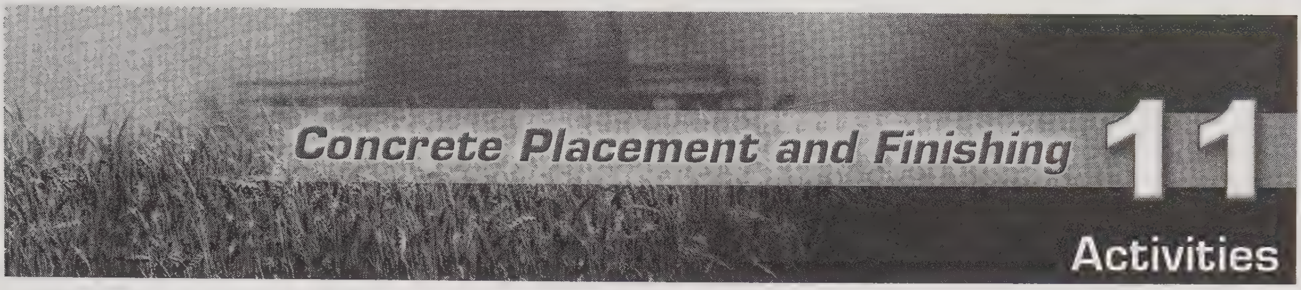


Concrete Placement and Finishing 11

Activities

Name ____ **Date** ____________________

Activity 11-1: Frost Heave

Low temperatures can cause groundwater to freeze and pose the danger of frost heave below the slab. Frost heave is the lifting of a surface such as concrete or pavement as a result of freeze-thaw cycles occurring in the underlying soil. Certain geographic areas of the United States are more prone to frost heave than others.

Identify the following geographic areas as being always, sometimes, or rarely affected by frost heave.

____________________ **1.** Thief River Falls, ND

____________________ **2.** McGill, NV

____________________ **3.** Oregon, IL

____________________ **4.** Cross City, FL

____________________ **5.** Siler City, NC

____________________ **6.** Loudonville, OH

____________________ **7.** Oneida, NY

____________________ **8.** Rosewood, CA

____________________ **9.** Grant City, MO

____________________ **10.** Imperial, CA

Activity 11-2: Driveway Slope

Driveways are typically sloped ⅛″ to ¼″ per foot to provide adequate drainage of rainwater. The amount of slope must be taken into consideration when setting up driveway formwork. Calculating the difference in elevation between the edge forms is based on the following formula:

$$E_D = \frac{S \times R}{12}$$

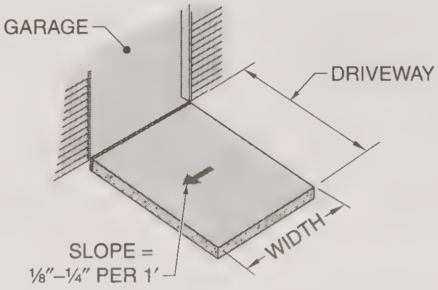
where

E_D = elevation difference (in in.)

S = slope (in in. per foot)

R = width (in in.)

12 = constant



Example: Determine the elevation difference between edge forms for a 10′ (120″) wide driveway sloped to one side at ¼″ (0.25″) per foot.

$$E_D = \frac{S \times R}{12}$$

$$E_D = \frac{0.25 \times 120}{12}$$

$$E_D = \frac{30}{12}$$

$$E_D = 2.5'' = \mathbf{2\tfrac{1}{2}''}$$

Determine the difference in elevation between edge forms for the following driveways.

________________ **1.** 20′ wide driveway sloped to one side at ¼″ per foot

________________ **2.** 15′ wide driveway sloped to one side at ¼″ per foot

________________ **3.** 30′ wide driveway sloped to one side at ⅛″ per foot

________________ **4.** 10′ wide driveway sloped to one side at ⅛″ per foot

Activity 11-3: Vibration Rates

Small vibrators can commonly vibrate 5 cu yd/hr to 10 cu yd/hr, and heavy-duty vibrators can commonly vibrate 50 cu yd/hr. The volume of concrete is calculated by multiplying the thickness (in ft) by the width (in ft) by the length (in ft) and dividing by 27. The number of hours needed to vibrate a given volume of concrete is calculated by applying the following formula:

$$T = \frac{V}{r}$$

where
T = time (in hr)
V = volume (in cu yd)
r = rate (in cu yd/hr)

Example: Determine the amount of time required to vibrate a concrete slab measuring 6″ (0.5′) thick by 50′wide by 75′ long when the vibration rate is 10 cu yd/hr.

$$V = \frac{t \times w \times l}{27}$$

$$V = \frac{0.5 \times 50 \times 75}{27}$$

$$V = 69.5 \text{ cu yd}$$

$$T = \frac{V}{r}$$

$$T = \frac{69.5}{10}$$

$$T = \mathbf{6.9\ hr}$$

Determine the amount of time required to vibrate the following volumes of concrete.

________________ **1.** 30 cu yd of concrete vibrated at 7.5 cu yd/hr

________________ **2.** 45 cu yd of concrete vibrated at 5 cu yd/hr

________________ **3.** 100 cu yd of concrete vibrated at 30 cu yd/hr

________________ **4.** 125 cu yd of concrete vibrated at 10 cu yd/hr

________________ **5.** 125 cu yd of concrete vibrated at 35 cu yd/hr

Activity 11-4: Rate of Evaporation

Unhardened concrete is in danger of permanent damage when the rate of evaporation exceeds 0.2 lb/sq ft/hr. A weather condition chart can be used to estimate the expected rate of evaporation. To determine the rate of evaporation, apply the following procedure:

1. Find the air temperature and move up to the relative humidity curve.
2. Move right to the concrete temperature.
3. Move down to wind velocity.
4. Move left for rate of evaporation.

Example: If air temperature = 70°F, relative humidity = 40%, concrete temperature = 60°F, and wind velocity = 20 mph, then rate of evaporation = 0.1 lb/sq ft/hr.

Determine the rate of evaporation when the following conditions exist.

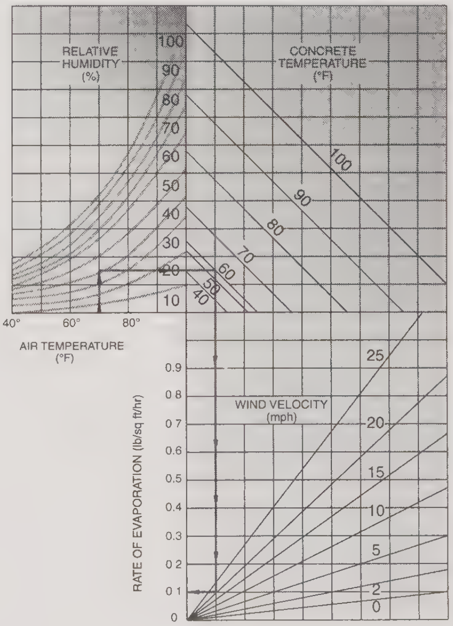
________________ **1.** Air temperature = 80°F; relative humidity = 40%; concrete temperature = 70°F; wind velocity = 5 mph

________________ **2.** Air temperature = 55°F; relative humidity = 40%; concrete temperature = 70°F; wind velocity = 5 mph

________________ **3.** Air temperature = 70°F; relative humidity = 60%; concrete temperature = 80°F; wind velocity = 15 mph

________________ **4.** Air temperature = 90°F; relative humidity = 80%; concrete temperature = 90°F; wind velocity = 15 mph

________________ **5.** Air temperature = 60°F; relative humidity = 50%; concrete temperature = 50°F; wind velocity = 25 mph



Activity 11-5: Area and Volume Calculations

Determine the area of the following concrete slabs.

____________________ **1.** Rectangular slab measuring 12′ long by 10′ wide

____________________ **2.** Slab measuring 20′ square

____________________ **3.** Rectangular slab measuring 100′ long by 25′ wide

____________________ **4.** Circular slab with a 20′-6″ diameter

____________________ **5.** Circular slab with a 15′ diameter

Determine the volume (in cu yd) of the following concrete structures.

____________________ **6.** Rectangular structure measuring 8″ thick by 10′ wide by 25′ long

____________________ **7.** Rectangular structure measuring 10″ thick by 12′ wide by 20′ long

____________________ **8.** Rectangular structure measuring 6″ thick by 15′ wide by 30′ long

____________________ **9.** Round column measuring 18″ in diameter by 20′ high

____________________ **10.** Round column measuring 24″ in diameter by 30′ high

Masonry 12

Review

Name ______________________________ Date ____________________

True-False

T F **1.** Jointers are usually cast or forged metal rods, or stamped split tubes with the ends rounded or angled to provide a particular shape or convex joint.

T F **2.** Line is available in different sizes, colors, and lengths up to 100′.

T F **3.** Masonry unit materials are fire-resistant and are commonly used as firebreaks between adjoining areas of a structure.

T F **4.** Norman bricks are shorter than most other bricks.

T F **5.** Face brick is used in areas subjected to high temperatures, such as fireplace hearths or welding stations.

T F **6.** CMUs are commonly referred to as blocks.

T F **7.** Flashing is a metal or flexible material embedded in a masonry wall to direct water out of the wall and prevent moisture penetration at exposed wall surfaces.

T F **8.** Sealants are caulked into movement joints to allow movement of the adjacent structure while sealing the open joint.

T F **9.** Concrete is a bonding mixture of fine aggregate (sand), lime, cement, and water and is used to fill voids between masonry units and reinforce a structure.

T F **10.** Type O mortar has a compressive strength of approximately 1800 psi but also has a moderately high shrinkage rate.

T F **11.** Each mortar type has a recommended proportion of cement, hydrated lime, and sand.

T F **12.** Cement provides the majority of the strength in a mortar mixture.

T F **13.** Mortar is rarely mixed on the job location.

T F **14.** A stretcher is a brick laid flat with the long face parallel to a wall.

T F **15.** The physical characteristics of both the mortar and masonry materials have a direct bearing on the strength of the bond.

T F **16.** Flashing is done when the mortar has set long enough to be "thumbprint hard," or when a thumb cannot be easily pressed into mortar.

T F **17.** Although waterproofing is the main reason for jointing, care must be taken not to seal the joint too tightly.

T F **18.** Brick bonds include running, American, common, and European bonds.

T F **19.** Common bond, or American bond, is a variation of running bond, with headers every fifth, sixth, or seventh course.

T F **20.** Masonry wall construction begins with a solid foundation of cast-in-place concrete.

T F **21.** Masonry walls cannot be structural bearing walls or a veneer built around and between structural members.

T F **22.** A sill is a single, continuous vertical masonry wall that is one unit thick.

T F **23.** Masonry material quantities can be calculated by determining the gross surface area (in square feet) of masonry for the project.

T F **24.** The number of blocks required for a wall is determined by calculating the wall surface area in square feet and multiplying the area by a standard multiplier.

T F **25.** Mortar amount is determined by brick size.

Multiple Choice

____________ **1.** ___ is a bonding mixture of fine aggregate, cement, and water that is used to fill voids between masonry units and reinforce a structure.

A. Concrete
B. Sand
C. Mortar
D. Caulk

____________ **2.** A ___ is a hand tool used by masons for dressing brick.

A. brick hammer
B. brick trowel
C. line
D. jointer

____________ **3.** Levels most commonly used for masonry work are available in lengths from ___″ to ___″.

A. 35; 45
B. 42; 48
C. 52; 68
D. 65; 75

________________ **4.** Bricks are typically shipped on pallets that contain ____ bricks.

A. 100
B. 250
C. 322
D. 500

________________ **5.** Blocks include stretcher, corner, header, ___, column, jamb, screen, and split-face designs.

A. bond beam
B. lintel
C. sill
D. all of the above

________________ **6.** A ___ is reinforcement embedded in mortar joints and used to secure two or more members together.

A. tie
B. fastener
C. restraint
D. wire

________________ **7.** Mortar can be classified as Type ___ and O.

A. M
B. P
C. A
D. all of the above

________________ **8.** Type ___ mortar has a compressive strength of approximately 750 psi and a low shrinkage rate.

A. M
B. S
C. N
D. O

________________ **9.** ___ is the aggregate component in a mortar mixture.

A. Clay
B. Gravel
C. Sand
D. Cement

________________ **10.** Masonry units are commonly used in conjunction with other construction materials, such as ___.

A. wood or metal framing
B. structural steel
C. structural concrete
D. all of the above

______________ **11.** A ___ is a brick laid flat and perpendicular to the face of a wall.
A. stretcher
B. header
C. course
D. closure

______________ **12.** A ___ is any portion of a brick used to close up the bond next to the end brick of a course.
A. closure
B. jointer
C. header
D. rowlock

______________ **13.** Mortar for bed joints should be spread ___″ thick.
A. 1
B. 2
C. 3
D. 4

______________ **14.** A(n) ___ joint is a vertical joint that joins bricks at their sides.
A. expansion
B. head
C. cross
D. all of the above

______________ **15.** ___ bond alternates courses of headers and stretchers and is laid so that the joints between the stretchers are centered on the headers.
A. Flemish
B. Common
C. Running
D. English

Completion

______________ **1.** ___ is any structure built using individual units, such as bricks or blocks, bonded with mortar.

______________ **2.** A(n) ___ is a flat triangular-shaped trowel used by bricklayers for picking up mortar and spreading it on a wall.

______________ **3.** A(n) ___ is a hand tool used to finish the mortar joint between the masonry units.

______________ **4.** A(n) ___ is a special chisel-like hand tool used to cut bricks to exact measurements.

______________ **5.** A(n) ___ is a masonry unit made of clay or shale that is formed into a rectangular shape while soft and then fired in a kiln.

______________ **6.** ___ is brick manufactured from refractory ceramic materials that resist disintegration at high temperatures.

______________ **7.** A(n) ___ is a precast hollow or solid block made of portland cement and fine aggregate, with or without admixtures or pigments.

______________ **8.** A(n) ___ joint is a continuous vertical or horizontal joint in a masonry wall that is made without mortar or other nonresilient materials and used to accommodate the expansion and contraction of the wall system.

______________ **9.** A(n) ___ is a steel angle iron attached to structural backing members to support horizontal courses of brick for high masonry walls.

______________ **10.** ___ is the degree of smoothness and workability of a mixture.

______________ **11.** A(n) ___ is a horizontal layer of brick in a masonry structure.

______________ **12.** A(n) ___ joint is a horizontal joint upon which bricks rest.

______________ **13.** A(n) ___ joint is a vertical joint that joins bricks at their ends.

______________ **14.** ___ is the process of finishing a joint to make it waterproof and improve appearance.

______________ **15.** A(n) ___ is the arrangement of masonry units in a wall created by overlapping the units to provide a sturdy structure.

______________ **16.** ___ bond alternates headers and stretchers in each course.

______________ **17.** ___ and water are commonly mixed together and used after the mortar has set to remove any excess mortar from the face of the masonry.

______________ **18.** A(n) ___ is a vertical masonry structure in which the facing and backing wythes are separated by a 2″ minimum void.

______________ **19.** ___ masonry is commonly laid with ½″ mortar joints.

______________ **20.** Type ___ mortar is commonly used for below-grade applications.

Short Answer

1. What is a wythe?

2. What is a face brick?

3. Which mortar type has the highest cement content and the highest compressive strength characteristics of all mortar types?

4. In masonry, what is a joint?

5. Which type of bond uses stretcher courses with the joints breaking at the center of each brick immediately above and below?

Identification

Masonry Tools

Identify the masonry tools.

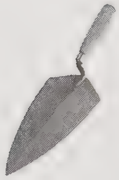
__________ **1.** Brick hammer

__________ **2.** Brick set

__________ **3.** Brick trowel

__________ **4.** Jointer

__________ **5.** Line



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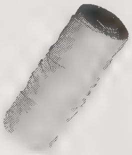

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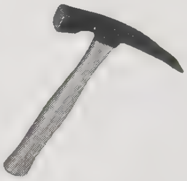

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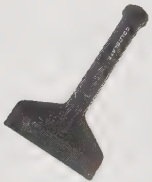

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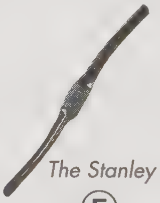

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Building Bricks

Identify the building bricks.

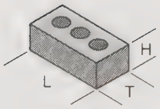
__________ **1.** Economy

__________ **2.** Engineer

__________ **3.** Norman

__________ **4.** SCR

__________ **5.** Standard modular



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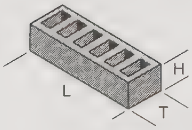

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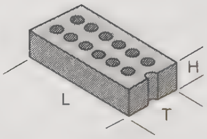

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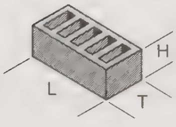

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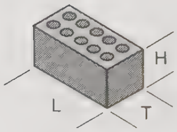

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Blocks

Identify the block types.

__________ **1.** Bond beam

__________ **2.** Column

__________ **3.** Corner

__________ **4.** Header

__________ **5.** Jamb

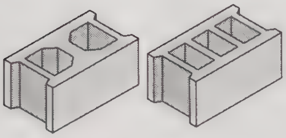
__________ **6.** Lintel

__________ **7.** Screen

__________ **8.** Sill

__________ **9.** Split face

__________ **10.** Stretcher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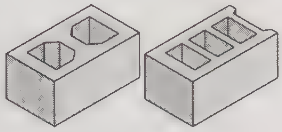
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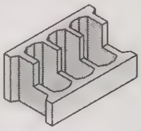
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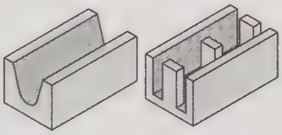
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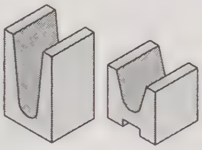
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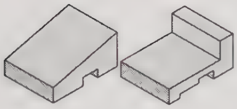
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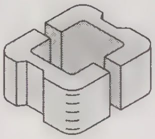
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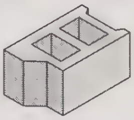
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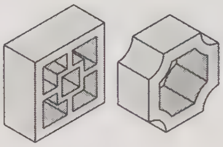
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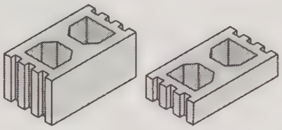
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Brick Positions

Identify the brick positions.

__________ **1.** Header

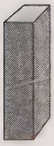
__________ **2.** Rowlock

__________ **3.** Sailor

__________ **4.** Shiner

__________ **5.** Soldier

__________ **6.** Stretcher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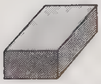
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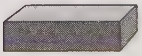
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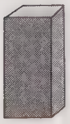
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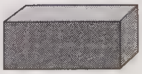
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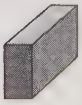
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Brick Bonds

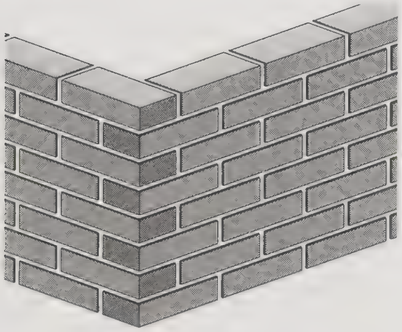
Identify the brick bonds.

____________________ **1.** Common

____________________ **2.** English

____________________ **3.** Flemish

____________________ **4.** Running



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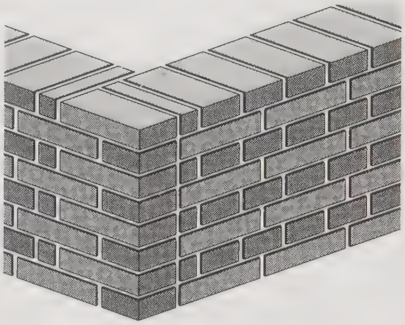

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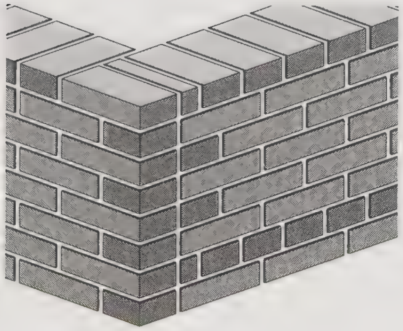

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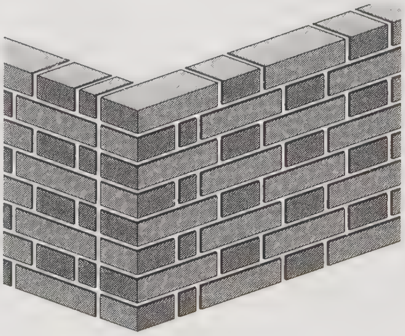

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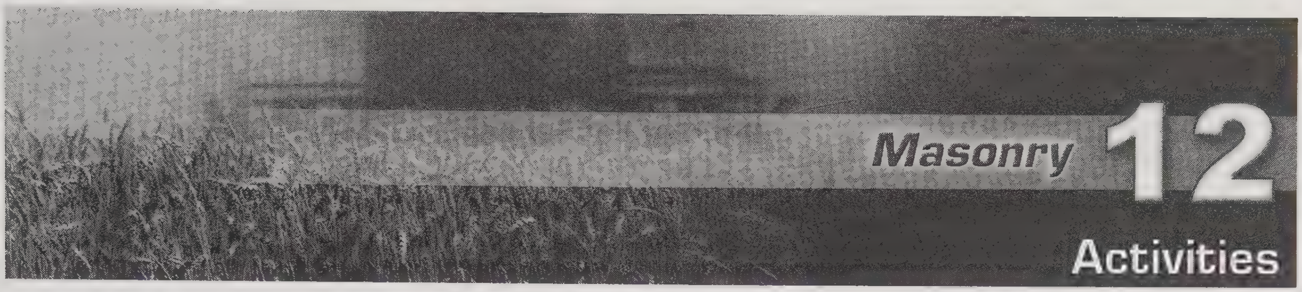


Masonry 12
Activities

Name ______________________________ **Date** ____________________

Activity 12-1: Spreading Mortar on Bricks

When working with masonry, an understanding of how to properly apply and spread mortar on bricks and blocks is required.

Practice spreading mortar on a length of one to six bricks by applying the following procedure.

Materials and Tools Required:

- Mortar pan and stand
- Brick trowel
- 5′ long section of 2″ × 4″ lumber
- Six 4″ wide bricks
- Mortar mixture (mixed to manufacturer's instructions)
- Bucket of clean water
- Plumb line or carpenter's level
- Jointer
- Stiff-bristled brush
- Folding rule

Note: Always wear proper PPE such as safety glasses or goggles, sturdy shoes, and sturdy clothing when performing masonry work. Clean all tools immediately after use.

Procedure:

1. Stage one section of 2″ × 4″ lumber and bricks within a 2′ distance from one another on level ground.
2. Place mortar pan on stand.
3. Moisten mortar pan with clean water.
4. Add mortar mixture to mortar pan.
5. Use brick trowel to cut mortar from pan and spread enough mortar mixture for six bricks evenly along top surface of 2″ × 4″ section.
6. Cut off excess mortar with tip of trowel and return to mortar pan. Add water as required to mortar pan to keep mortar in good working condition.
7. Set one course of six bricks on the mortar bed.
8. Adjust bricks to level position and check with plumb line or level.
9. Check height of brick course with folding rule. Adjust height as required.
10. After mortar is thumbprint hard, strike the joints with jointer and brush bricks with stiff-bristled brush to remove excess dirt and mortar.

Activity 12-2: Cutting Bricks

When working with masonry, an understanding of how to properly cut bricks is required.

Practice cutting bricks by applying the following procedure.

Materials and Tools Required:

- 2′ long section of 2″ × 4″ lumber
- Bricks
- Brick hammer
- Brick set
- Carpenter's pencil or scribing tool

Note: Always wear proper PPE such as safety glasses or goggles, sturdy shoes, and sturdy clothing when performing masonry work. Clean all tools immediately after use.

Procedure:

1. Use carpenter's pencil or scribe to mark or scribe one brick where it is to be cut.
2. Use sharp end of hammer to score all four sides of brick.
3. Place brick on section of 2″ × 4″ lumber.
4. Use hammer to strike brick near score mark to complete the cut.

Note: A brick can also be cut with a brick set by holding the brick set against the brick and striking the top of the brick set with a hammer.

Agricultural Building Methods and Structures

13

Review

Name ______________________________ Date ____________________

True-False

T F **1.** A footing only needs to extend to a depth below the frost line for certain applications.

T F **2.** Not all agricultural structures have footings.

T F **3.** Walls may be load-bearing or non-load-bearing.

T F **4.** While many agricultural structures can be pole or post frame, many are wood frame.

T F **5.** Pole-frame structures use square pressure-treated posts as their primary support.

T F **6.** The most common roof and wall covering for post-frame buildings is corrugated steel, which is commonly prepainted.

T F **7.** A shed roof is the most popular type of roof used in agricultural applications due to its simple design, ease of construction, and adaptability for many agricultural structures.

T F **8.** The basic structural members of a gable roof are the ridge board, rafters, and gable studs.

T F **9.** Most lumber used in agricultural structures is framing lumber.

T F **10.** Wood framing members are straighter than steel framing members, allowing structures to be constructed with greater precision.

T F **11.** Structural steel framing incorporates the use of steel columns, beams, and girders connected in a manner similar to wood post-and-beam construction.

T F **12.** Light-gauge steel framing members receive a protective coating to prevent corrosion during transportation, storage, and final placement.

T F **13.** When structural damage occurs from an earthquake, tornado, or hurricane, it is typically the result of framing members being pulled loose at their joints rather than being broken along their length.

T F **14.** To prevent corrosion, metal connectors, washers, and bolts must be in direct contact with pressure-treated wood.

T F **15.** In regions where heavy snowfall is normal, greenhouses should be located at least 10′ away from any trees in order to limit exposure to snow drifts.

T F **16.** Underground well water is preferred for greenhouse irrigation, as municipal water is often costly and may contain harmful treatment chemicals such as fluoride.

T F **17.** Glass-panel greenhouses have an initial price that is higher than double-layer film greenhouses but lower maintenance cost.

T F **18.** A plastic-film greenhouse uses two or more even-span gable structures connected at the eaves.

T F **19.** Two common types of plastic-film greenhouses are Quonset and gutter-connected type greenhouses.

T F **20.** Quonset greenhouses are more efficient than multiple smaller gutter-connected greenhouses due to the larger, unrestricted areas.

T F **21.** Acrylic panels have higher light transmission and longer life than polycarbonate panels.

T F **22.** The major advantage of hydroponic CEA compared to field grown produce is the isolation of the crop from the soil, which often has problems of diseases, pests, salinity, poor structure, and/or drainage.

T F **23.** The only types of aquaculture systems are flow-through and recirculating systems.

T F **24.** Pond aquaculture systems are typically only used to raise aquatic plants and vegetation.

T F **25.** Ponds are best when constructed in wetlands.

Multiple Choice

__________ **1.** Footings must be installed to a minimum depth below the frost line of ___″.
   A. 6
   B. 10
   C. 12
   D. 18

__________ **2.** ___ frame systems are built with a combination of wood and metal frame members and covered with metal panels.
   A. Pole
   B. Rigid arch
   C. Concrete masonry
   D. all of the above

__________ **3.** A ___ is the part of a building that rests on and extends into the ground to provide support for structural loads.
   A. metal connector
   B. joist
   C. foundation
   D. stud

________________ **4.** The inclination of a roof can be expressed as either roof slope or roof ___.
A. angle
B. length
C. pitch
D. squares

________________ **5.** With pole-frame structures, the walls and roof are supported by the ___.
A. poles
B. beams
C. posts
D. all of the above

________________ **6.** "Steel-for-stick" construction is also known as ___ construction.
A. wood frame
B. CMU and timber
C. light-gauge steel
D. all of the above

________________ **7.** ___ types commonly used for agricultural structures are shed, gable, monitor, gambrel, gothic, half monitor, offset gable, and hip.
A. Wall
B. Roof
C. Foundation
D. Frame

________________ **8.** A(n) ___ roof can allow for more natural lighting or extra storage.
A. shed
B. half-monitor
C. gable
D. offset gable

________________ **9.** Some of the most commonly used metal connectors are ___.
A. framing nails
B. bolts
C. rivets
D. none of the above

________________ **10.** Gable-roof greenhouses located above ___° N latitude should be oriented with the ridge line running east to west.
A. 10
B. 20
C. 30
D. 40

________________ **11.** A(n) ___ greenhouse is installed against the side of an existing structure to reduce the cost of construction and, ideally, should be placed on the south wall of the existing structure.
A. ridge-and-furrow
B. even-span gable
C. uneven-span gable
D. none of the above

______________ **12.** ___ is the growing of crops in a nutrient solution without the use of a supporting material.
A. Harvesting
B. Aquaculture
C. Hydroponics
D. Cultivation

______________ **13.** Hydroponic structures are designed for the hydroponic growing of crops and typically include ___ and ventilation units.
A. nutrient reservoirs
B. ropes to support vertical growth
C. oscillating fans
D. all of the above

______________ **14.** ___ is the cultivation and harvesting of the natural products of water.
A. Irrigation
B. Aquaculture
C. Hydroponics
D. Dredging

______________ **15.** Crops typically grown in hydroponic structures include ___.
A. corn
B. soybeans
C. wheat
D. strawberries

Completion

______________ **1.** ___ frame systems use a totally integrated engineering style not normally found in conventional construction.

______________ **2.** The ___ used with framing systems are footings, foundations, walls, and roofs.

______________ **3.** The three most common types of foundations used with agricultural structures are continuous concrete, treated post, and ___.

______________ **4.** A(n) ___ is a vertical structure used as a partition to enclose or divide areas.

______________ **5.** A(n) ___ is a wooden horizontal stiffener placed around the perimeter of a post-frame structure to support the wall covering.

______________ **6.** A(n) ___ is an exterior top covering of a structure.

______________ **7.** A(n) ___ roof is easy to construct and popular for many low-cost agricultural buildings, such as buildings used for animal shelter and machinery storage.

______________ **8.** ___ is an expression of roof inclination stated as a ratio of the vertical rise to the horizontal run of 12″, such as 3:12, 4:12, 6:12, etc.

____________________ **9.** ___ are upright framing members that provide a nailing surface for siding and sheathing at the gable ends of the roof.

____________________ **10.** ___ lumber includes dimension lumber, special dimension lumber, and timber classifications.

____________________ **11.** Structural steel columns are typically fastened to concrete foundations and slabs with ___ during construction.

____________________ **12.** Some ___ steel framing members have a dimpled surface applied during manufacturing.

____________________ **13.** Modern wood preservatives typically have high ___ content, which makes them more corrosive to metal connectors and fasteners than traditional wood preservatives.

____________________ **14.** A(n) ___ is a translucent, glass-enclosed or plastic-enclosed structure with temperature and humidity control used for the purpose of admitting natural light for supporting plant growth.

____________________ **15.** ___ type greenhouses should be oriented north to south.

____________________ **16.** A(n) ___ gable greenhouse has roof slopes of unequal width, which make the structure a good choice when used on a hillside.

____________________ **17.** ___ panels are used more commonly with greenhouse construction due to lower cost, flame resistance, and greater resistance to hail damage.

____________________ **18.** A(n) ___ is a specialized greenhouse erected to support hydroponic crops.

____________________ **19.** A(n) ___ aquaculture system is constructed in a manner that allows it to receive a constant flow of water.

____________________ **20.** A(n) ___ is a building that is assembled and constructed in components, modules, or transportable sections.

Short Answer

1. What is the main advantage of a recirculating aquaculture system?

2. List three common styles of glass-panel greenhouses used in agricultural applications.

3. List two advantages that double-layer plastic film greenhouses have over glass- or rigid-panel greenhouses.

4. List four advantages of hydroponic controlled environment agriculture (CEA).

5. List five factors that must be considered when locating and designing an aquaculture system.

Identification

Structural Framing Systems

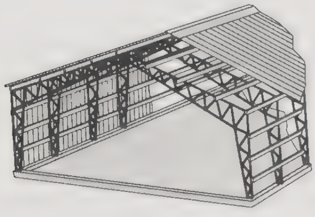
Identify the structural framing systems.

__________ **1.** Concrete masonry

__________ **2.** Pole frame

__________ **3.** Rigid arch

__________ **4.** Stud frame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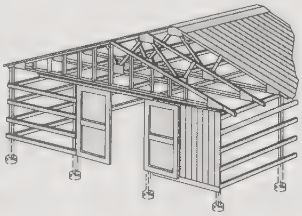
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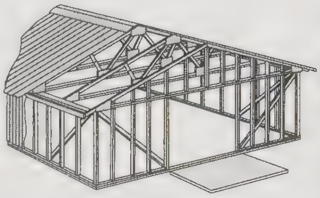
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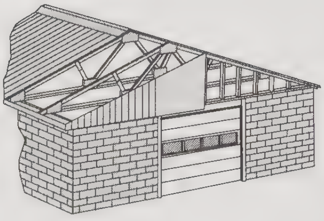
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Agricultural Structure Roof Types

Identify the agricultural structure roof types.

__________ **1.** Gable

__________ **2.** Gambrel

__________ **3.** Gothic

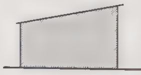
__________ **4.** Half monitor

__________ **5.** Hip

__________ **6.** Monitor

__________ **7.** Offset gable

__________ **8.** Shed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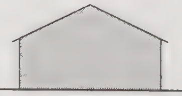
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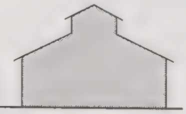
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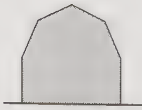
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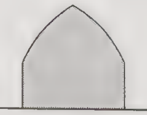
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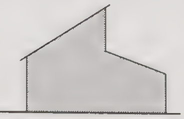
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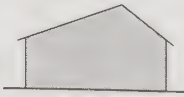
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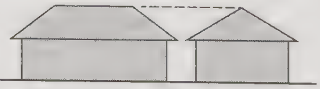
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Gable Roof Framework

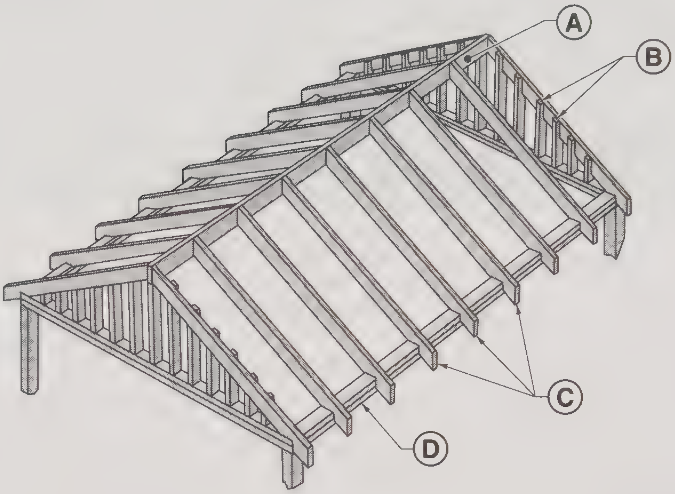
Identify the gable roof framework sections.

______________ **1.** Common rafters

______________ **2.** Double top plate

______________ **3.** Gable studs

______________ **4.** Ridge board



Structural Steel Framing

Identify the structural steel framing components.

______________ **1.** Cable or rod bracing at roof

______________ **2.** Cable or rod bracing at wall

______________ **3.** Downspout

______________ **4.** Eave strut

______________ **5.** Gutter

______________ **6.** Ridge line

______________ **7.** Ridge panel

______________ **8.** Rigid frame column

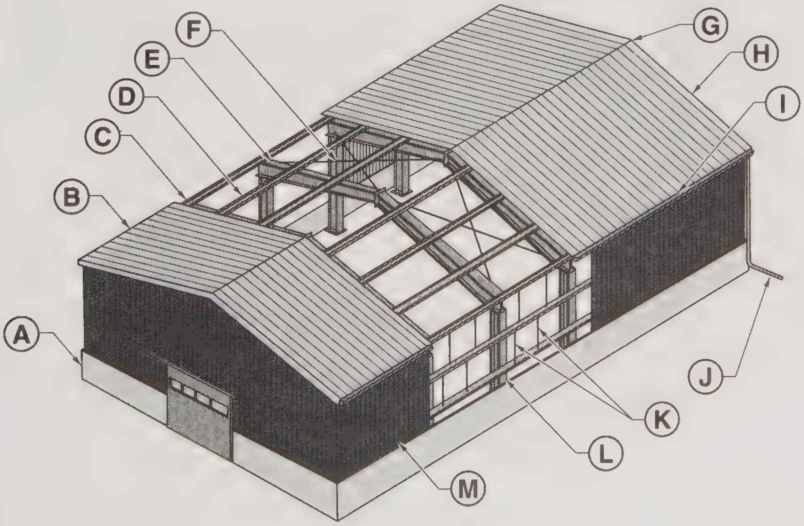
______________ **9.** Rigid frame rafter

______________ **10.** Roof panel

______________ **11.** Roof purlin

______________ **12.** Sidewall

______________ **13.** Wall panel



Metal Connectors

Identify the metal connectors.

______________ **1.** Beam hanger

______________ **2.** Framing anchors

______________ **3.** Holddown

______________ **4.** Joist hangers

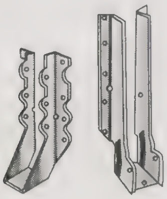
______________ **5.** Joist support

______________ **6.** Post base

______________ **7.** Post cap

______________ **8.** Strap tie holddown

______________ **9.** Tie down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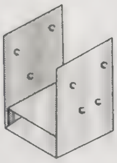
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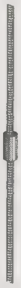
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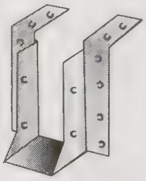
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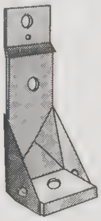
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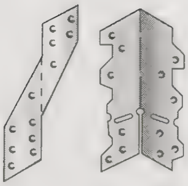
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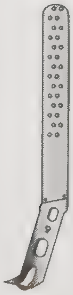
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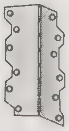
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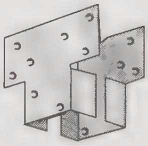
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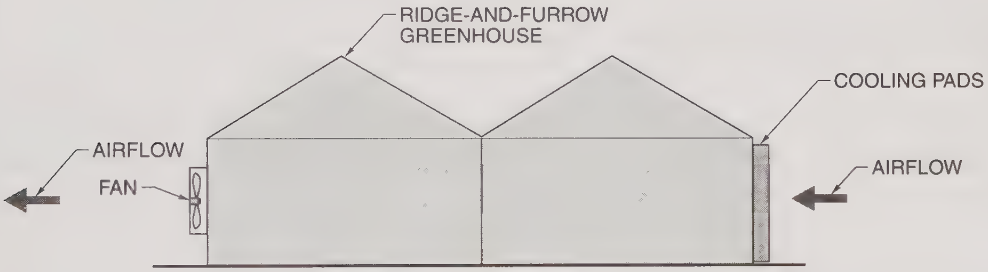
Agricultural Building Methods and Structures 13

Activities

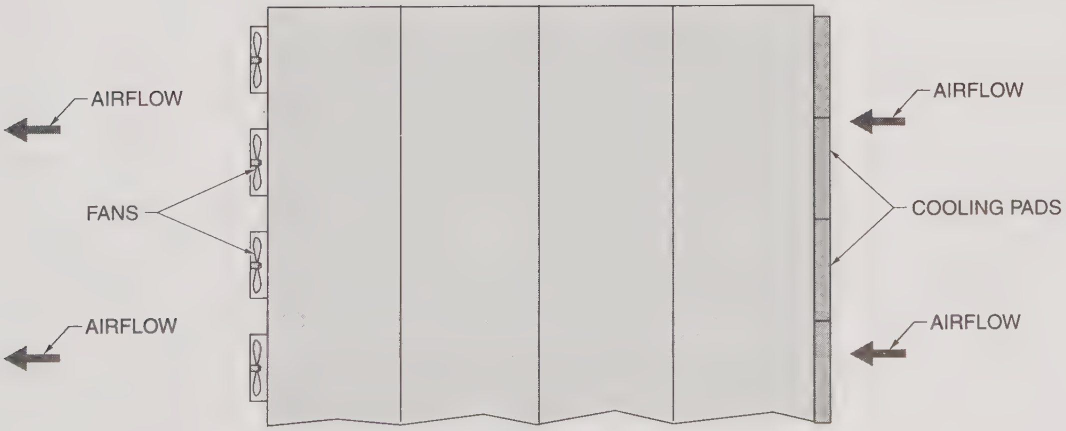
Name ______________________________ Date ____________________

Activity 13-1: Calculating Greenhouse Cooling Pad Size

Wet cooling pads are installed on the windward side of greenhouses for ventilation systems to increase the effect of fans used for exhausting air within greenhouse structures. For example, when fans exhaust internal air, a partial vacuum is created within the greenhouse. Additional air is pulled into the greenhouse and cooled through a moistened fiber or paper pad mounted on the side of the greenhouse. The cooled air then absorbs heat in the greenhouse and exhausts it out of the structure. Cooling pads work best in geographic areas with low relative humidity. Typically, the amount of pad required to provide the best cooling results is 1 sq ft of pad for each 150 cu ft of air moved per minute (cfm). For example, airflow of 20,000 cfm would require 134 sq ft of pad area.


RIDGE-AND-FURROW GREENHOUSE
COOLING PADS
AIRFLOW
FAN
AIRFLOW

SIDE ELEVATION


AIRFLOW
AIRFLOW
FANS
COOLING PADS
AIRFLOW
AIRFLOW

PLAN VIEW

Calculate the following pad area requirements.

______________ **1.** 10,000 cfm = ___ sq ft of pad

______________ **2.** 15,750 cfm = ___ sq ft of pad

______________ **3.** 30,000 cfm = ___ sq ft of pad

______________ **4.** 25,000 cfm = ___ sq ft of pad

______________ **5.** 42,000 cfm = ___ sq ft of pad

Identify the following geographic areas as being suitable or not suitable for installation of greenhouse cooling pads.

______________ **6.** Montgomery, AL

______________ **7.** Houston, TX

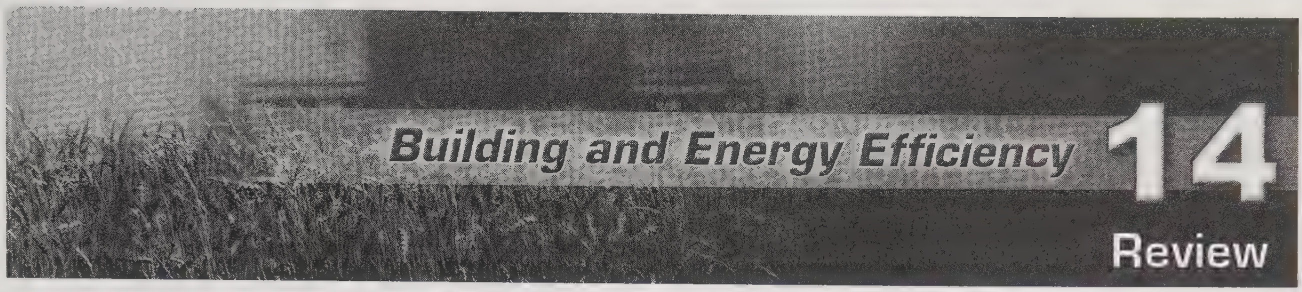
______________ **8.** Boise, ID

______________ **9.** Tucson, AZ

______________ **10.** Fresno, CA

Activity 13-2: Hydroponic Structures

1. Sketch a design of a hydroponic structure that can be used to grow at least three different high-revenue crops, such as cucumbers or strawberries. The design should include nutrient reservoirs, ropes to support vertical growth, oscillating fans, and ventilation units.



Building and Energy Efficiency

14

Review

Name ______________________________ Date ____________________

True-False

T F **1.** The three methods by which heat transfer occurs are conduction, convection, and radiation.

T F **2.** Convection is the direct transmission of heat by invisible waves similar to light waves.

T F **3.** Insulation materials protect a building from losing heat or coolness by any method of heat transfer.

T F **4.** Heat is measured in British thermal units (Btu).

T F **5.** The C factor is a decimal measurement of how many Btu per hour (Btu/hr) pass through 1 sq ft of material that is 1″ thick and has a temperature difference of 1°F between its inside and outside surfaces.

T F **6.** Moisture is always present in the air, although it is usually not visible to the naked eye.

T F **7.** Wind effect is based on the principle that warm air rises.

T F **8.** Condensation must be prevented in all structures because it can lead to hidden problems such as mold, insect damage, and weakening of wooden strength members.

T F **9.** Most venting methods have disadvantages when used as stand-alone systems but are effective when combined with other methods.

T F **10.** Thermal insulation resists heat flow into a building during cold weather and heat flow out of a building during hot weather.

T F **11.** The most widely used insulation (fiberglass insulation) is manufactured from melted glass that is spun into fibers.

T F **12.** Blown-in blanket insulation can be blown or packed into exterior wall cavities of older buildings that were not insulated when originally constructed.

T F **13.** Loose-fill insulation is a type of insulating material in which retention fabric made of spun polypropylene is fastened to wall studs using adhesive or staples before gypsum board or another interior wall covering is applied.

T F **14.** Blanket-and-batt insulation is available with faced or unfaced surfaces.

T F **15.** Foamed-in-place insulation consists of polyurethane and polystyrene foam or fiberglass strands pressed into panels.

T F **16.** Rigid-foam insulation is available in faced and unfaced panels.

T F **17.** Ultraviolet light from the sun degrades the insulation value of rigid-foam insulation.

T F **18.** Approximately 60% of a building's heat loss can occur due to air escaping through the roof.

T F **19.** Rigid-roof insulation can be used for low-pitched roofs or flat roofs.

T F **20.** Single-ply and built-up roofing systems are rarely used as flat roof covering systems.

T F **21.** Metal roof decking panels provide a high strength-to-weight ratio that reduces the amount of dead load on a structure.

T F **22.** Most heat loss occurs as a result of air infiltration, which is air leakage through cracks around window and door frames.

T F **23.** Minor amounts of heat loss caused by infiltration can be eliminated by sealing cracks around doorjambs and window frames.

T F **24.** Windows can be the greatest source of heat loss during the winter and heat gain during the summer because glass is a poor insulation material.

T F **25.** Glass-filled windows are three to four times more energy efficient than standard multiple-pane windows.

Multiple Choice

______________ **1.** ___ is the movement of heat through a solid or liquid.
A. Radiation
B. Convection
C. Conduction
D. Combustion

______________ **2.** Technical information about each type of insulation is expressed using letters that represent certain factors, including ___.
A. conductivity (K)
B. conductance (U)
C. transmittance (C)
D. all of the above

______________ **3.** The ___ factor applies to materials of any thickness that are not homogenous or that have air cavities, such as hollow concrete masonry units.
A. C
B. K
C. R
D. U

____________________ **4.** The ___ value is a numerical value that represents the ability of a material to resist heat flow.

A. C
B. K
C. R
D. U

____________________ **5.** ___ is the conversion of a substance from a vapor to a liquid state by the removal of heat.

A. Condensation
B. Combustion
C. Radiation
D. Convection

____________________ **6.** Modern construction often requires installation of vapor barriers with perm ratings of ___ or less.

A. 0.005
B. 0.05
C. 0.5
D. 5

____________________ **7.** A(n) ___ prevents damage to the insulation material from the moisture that collects inside a wall.

A. exterior envelope
B. vapor barrier
C. ventilation chute
D. all of the above

____________________ **8.** A ___ is a unit of measurement that indicates permeability and is based on a formula that measures the water vapor flow through the thickness of a single material or combined materials.

A. resistance value
B. perm rating
C. Btu
D. none of the above

____________________ **9.** Crawl space ventilation methods include ___.

A. metal louver foundation vents
B. continuous ridge vents
C. gable louver vents
D. all of the above

____________________ **10.** ___ vents are located beneath a roof cornice and may consist of a series of small openings or one continuous slot.

A. Rafter
B. Gable end louvers
C. Soffit
D. Continuous ridge

______ **11.** Batts used with blanket-and-batt insulation are usually ___″ long.

A. 12
B. 24
C. 36
D. 48

______ **12.** ___ insulation is material manufactured as small granules or particles and is poured or blown into voids in floors, walls, or roofs to reduce thermal or sound transmission.

A. Loose-fill
B. Foamed-in-place
C. Rigid-foam
D. Blanket-and-batt

______ **13.** ___ insulation is a type of material used to inhibit transmission of temperature and sound.

A. Blanket-and-batt
B. Loose-fill
C. Rigid-foam
D. Foamed-in-place

______ **14.** ___ is a closed-cell material typically sandwiched between sections of asphalt-saturated felt or glass fiber facing.

A. Mineral fiber
B. Perlite
C. Polyisocyanurate
D. Cellular glass

______ **15.** Studies have shown that up to ___% of total heating load within a structure is used to replace heat lost through doors and windows.

A. 25
B. 35
C. 53
D. 70

Completion

______ **1.** ___, also known as building dynamics or building physics, is the study of interaction between a building (including its HVAC, mechanical, and electrical systems), its inhabitants, and the surrounding environment.

______ **2.** ___ is the movement of increased temperature from one material to another.

______ **3.** A(n) ___ is a material that readily transmits heat.

______ **4.** ___ is the movement of heat through the circulatory motion of air or liquid.

______ **5.** A(n) ___ is the quantity of heat required to raise the temperature of 1 lb of pure water 1°F at or near the temperature of maximum density of water (39°F).

______ **6.** A(n) ___ is the measure of the thermal conductivity of a material.

______ **7.** The ___ is the temperature at which condensation occurs.

______________ **8.** A(n) ___ is an element within a structure that encloses a conditioned space.

______________ **9.** The ___ effect is created by wood-, oil-, or natural-gas-burning appliances that require makeup air to support combustion.

______________ **10.** A(n) ___ is an impervious chemical or material that retards movement of vapor or moisture through a structure or other surface.

______________ **11.** ___ vents run along the ridge of a roof.

______________ **12.** ___ insulation is a material with a high thermal resistance and that limits the transfer of heat.

______________ **13.** ___ insulation is the material most widely used to insulate walls, floors, ceilings, and attics.

______________ **14.** ___ insulation is chemical foam that is poured or sprayed into wall cavities.

______________ **15.** ___ insulation consists of polyurethane and polystyrene foam or fiberglass strands pressed into panels.

______________ **16.** A(n) ___ is a method that provides exterior building protection through the application of exterior sheathing, insulation board, reinforcing mesh, a base coat of acrylic polymers and portland cement, and a finish of acrylic resins.

______________ **17.** ___ is rigid-foam insulation that is composed of expanded volcanic minerals combined with organic fibers and binders.

______________ **18.** ___ roofing consists of layers (plies) of roofing felt bonded together while the roof is under construction with hot bitumen.

______________ **19.** ___ is a resilient material made of latex, oil, asphalt, butyl rubber, or silicone used to seal joints and cracks.

______________ **20.** ___ is material, such as metal, felt, or neoprene, placed between adjoining members to seal the joint and prevent precipitation, moisture, or draft from entering a structure.

Short Answer

1. What are the three methods by which heat transfer occurs?

2. How does the U factor differ from the K and C factors?

3. Explain how thermal insulation is rated and what the rating is used to indicate.

4. In addition to providing insulation for walls, list three advantages of using rigid-foam insulation panels.

5. What is the best method for sealing cracks between a doorjamb or window frame and the exterior wall?

Identification

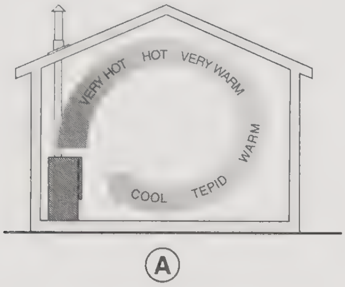
Heat Transfer

Identify the types of heat transfer.

__________________ **1.** Conduction

__________________ **2.** Convection

__________________ **3.** Radiation


VERY HOT
HOT
VERY WARM
WARM
TEPID
COOL
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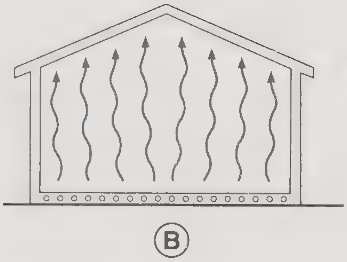
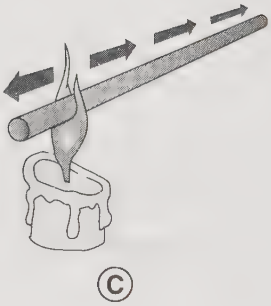




Metal Roof Decking

Identify the types of metal roof decking.

__________________ **1.** Acoustical deck

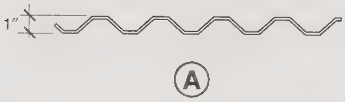
__________________ **2.** Cellular

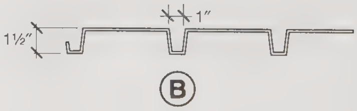
__________________ **3.** Economy

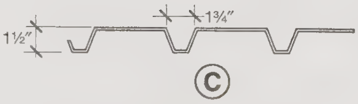
__________________ **4.** Intermediate rib

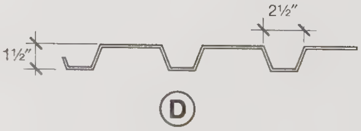
__________________ **5.** Narrow rib

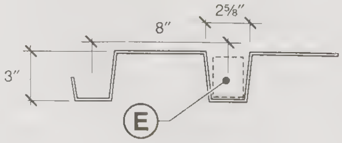
__________________ **6.** Wide rib

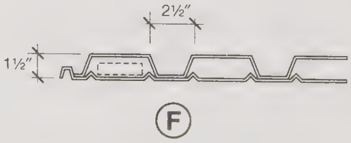


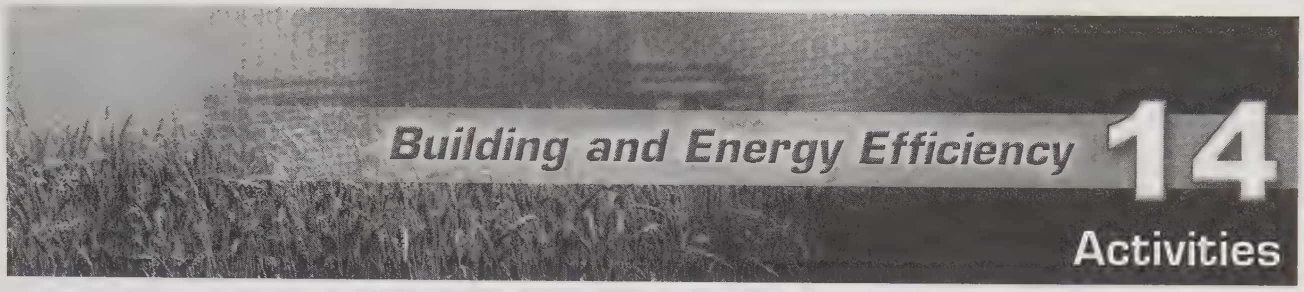












Building and Energy Efficiency 14

Activities

Name ______________________________ Date ____________________

Activity 14-1: Measurements and Calculations

Multiply and divide the following compound measurements.

__________ **1.** 2 yd, 15′-200″ × 3 = ___

__________ **2.** 7 yd, 3′-16″ × 2 = ___

__________ **3.** 4 yd, 5′-30″ × 7 = ___

__________ **4.** 4 yd, 3′-26″ ÷ 2 = ___

__________ **5.** 8 yd, 4′-16″ ÷ 4 = ___

__________ **6.** 1 yd, 7′-11″ ÷ 3 = ___

__________ **7.** 8 yd, 7′-29″ ÷ 2 = ___

__________ **8.** 7 yd, 2′-20″ ÷ 4 = ___

__________ **9.** 2 yd, 5′-9″ ÷ 3 = ___

__________ **10.** 9 yd, 15′-65″ × 6 = ___

__________ **11.** 35 yd, 8′-19″ × 5 = ___

__________ **12.** 5 yd, 4′-88″ × 2 = ___

Answer the following questions.

__________ **13.** An agricultural mechanic measured the height of a wall to be 96″ tall. What is the height of the wall in feet?

__________ **14.** The thickness of a wall is measured to be 0.5′. What is the thickness of the wall in inches?

__________ **15.** A contractor wants to cut a 2 × 4 that is 9′-7″ long into four equal pieces of wood. What is the length of each piece of wood?

__________ **16.** What is 10′-6″ when converted to only inches?

__________ **17.** A room in an outbuilding is 9′-10″ wide. The doorway and window openings in the room have been measured in inches. How wide is the room in inches?

____________________ **18.** What is 35 sq yd, 20 sq ft when converted to only square feet?

____________________ **19.** Two boards have lengths of 3 yd, 2′-3″ and 2 yd, 5′-8″. What is the total length of the two boards?

____________________ **20.** What is 80,450 sq in. when converted to sq ft?

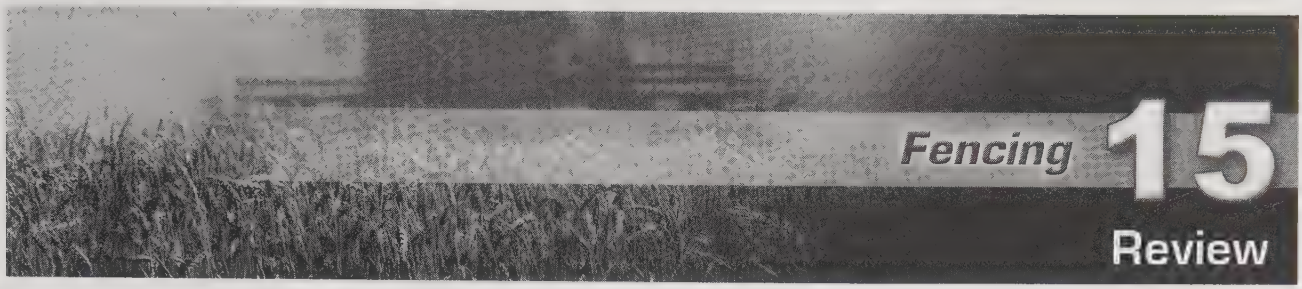
____________________ **21.** A dairy farmer plans to paint the concrete floor in a room that has an area of 200 sq ft. What is the area of the room in square meters?

____________________ **22.** A worker installing blanket-and-batt insulation in a room that has 500 sq ft of wall area needs to find out the area of the room's walls without window openings. There are two windows in the room measuring 36″ × 36″ and 48″ × 36″. What is the actual area (in square feet) of insulation needed?

____________________ **23.** A trench that is 24′ long, 5′ wide, and 4′ deep needs to be filled with dirt. What is the total volume (in cubic yards) of dirt needed to fill the trench?

____________________ **24.** A steel I-beam that is to be installed in a pole barn weighs 1500 lb. What is the I-beam's weight in kilograms?

____________________ **25.** A metal gear weighs 32 kg. What is the gear's weight in lb?



Fencing 15

Review

Name ______________________________ Date ____________________

True-False

T F **1.** A security fence is a fence line around the outer boundary of a property.

T F **2.** Aesthetic fences are installed for the sole purpose of limiting visibility from publicly accessible areas.

T F **3.** Most agricultural fencing is used for livestock control or protection from predators.

T F **4.** In agricultural fencing applications, wood posts are preferred because of their lower cost.

T F **5.** Polymer-grid fencing is only used for temporary installations.

T F **6.** USDA guidelines require that when planning the location of fencing for livestock, consideration must be given to the topography and the location of water, trees, and other natural barriers.

T F **7.** Fencing installed to prevent deer from entering a specific area must be at least 10′ above the ground.

T F **8.** Temporary fencing normally is used for several weeks or months and allows pastures to be rotated or adjustments in the size of a pasture for the amount of livestock being grazed.

T F **9.** Proper fence installation requires the use of connectors such as staples, wires, and manufactured connectors.

T F **10.** Common fence types used in agriculture include wire fences, electrified fences, wire fabric fences, and rail fences.

T F **11.** A barbed wire is a wire made of single-strand or two-strand twisted mild steel wire.

T F **12.** Typically, five to seven strands of barbed wire are used with agricultural fences.

T F **13.** Electric wires are always attached to fence posts with porcelain or plastic connectors.

T F **14.** Woven wire fabric is commonly used with heavy-gauge wire or small-sized opening fabric.

T F **15.** No-climb wire fabric is composed of steel wires linked together in a chainlike pattern and is occasionally used to contain livestock in small areas where containment is critical.

T F **16.** Hardware cloth is commonly used to contain chickens, poultry, rabbits, or other small animals.

T F **17.** An X-post fence is a fence made of vertical support posts with series of horizontal rails or boards.

T F **18.** Vinyl fencing material is an acceptable alternative to wood and steel fencing material.

T F **19.** The local climate must always be taken into consideration when installing a fence.

T F **20.** When installing a barbed wire fence, corner or end posts must be set in the ground in a perfect vertical position prior to attaching any horizontal wires.

T F **21.** Barbed wire must never be used for horse fencing as it can cause serious harm to a horse that gets caught in the wire.

T F **22.** Most fence material and installation costs are only estimated by the unit distance.

T F **23.** To develop a new fence line, the end post locations are determined and the distance between the end posts is carefully measured.

T F **24.** When installing a fence on a slope, the posts are installed vertically and the wire, wire fabric, or rails are installed parallel to the ground.

T F **25.** Perimeter fences and cross fences are rarely visually inspected for required maintenance when livestock are contained.

Multiple Choice

______________ **1.** A ___ fence is a fence that is specifically used to divide a property.

A. perimeter
B. livestock control
C. cross
D. privacy

______________ **2.** Fences are used ___.

A. as permanent boundaries
B. as temporary dividers
C. to protect structures
D. all of the above

______________ **3.** Depending on the type of climate, properly installed pressure-treated wood can be in service from ___ years to ___ years.

A. 5; 10
B. 10; 12
C. 15; 25
D. 20; 30

______________ **4.** Most fence wire manufacturers use a Class ___ galvanized coating to prevent rust.
A. I
B. II
C. III
D. all of the above

______________ **5.** Fence posts are normally supplied in ___′ and ___′ lengths.
A. 2; 4
B. 4; 8
C. 8; 10
D. 10; 12

______________ **6.** A(n) ___ is a fence post that consists of a pair of connected members fixed in an angled position and used to support a fence.
A. corner post
B. X-post
C. fence brace
D. stock gap

______________ **7.** A ___ is a pair of fence posts with cross bracing and brace wire for tension that is used to transfer the tension force on the fencing material to the ground.
A. fence post connector
B. gate
C. fence brace
D. stock gap

______________ **8.** For most fencing applications, steel T-posts are normally driven to a depth of about ___′.
A. 1
B. 2
C. 3
D. 4

______________ **9.** For effective control without causing harm, small animals such as pets require an electrical shock ranging from ___ V to ___ V.
A. 50; 100
B. 250; 500
C. 700; 1000
D. 1200; 1500

______________ **10.** When installing barbed wire fences, the highest barbed wire strand is typically installed about ___″ above the ground.
A. 36
B. 40
C. 48
D. 60

________________ **11.** A(n) ___ is an inexpensive, flexible polyethylene fiber rope or tape interwoven with fine steel or copper wires and carries low amperage current.

A. electric braid
B. netting
C. fabric
D. wire

________________ **12.** ___ fencing is typically used where heavy concentrations of livestock are confined.

A. Chain-link fabric
B. Hardware cloth
C. Poultry-wire fabric
D. none of the above

________________ **13.** ___ wire fabric is made from thin wires woven together in ½″ to 1″ hexagonal openings with edge wires for stiffness.

A. Welded
B. No-climb
C. Woven
D. Poultry

________________ **14.** ___ fences may include a single strand of barbed wire or electric wire, depending on the type of livestock contained, to increase its effectiveness.

A. Rail
B. Polymer grid
C. Stockade
D. X-post

________________ **15.** A ___ is a movable fence section in a permanently fenced area that controls access.

A. gate
B. stock gap
C. cattle guard
D. floodgate

Completion

________________ **1.** A(n) ___ is a barrier intended to mark or prevent the incursion into or escape out of a boundary.

________________ **2.** ___ is a state requirement to enclose areas that contain livestock through the use of fencing.

________________ **3.** A(n) ___ fence is an electric or nonelectric fence used in agricultural locations to contain livestock within a defined area.

________________ **4.** ___ wood fences have closely spaced, vertical planks that provide a significant level of privacy and security.

__________________ **5.** ___ fences are typically only used for providing a pleasing appearance and privacy.

__________________ **6.** ___ posts are used if wood is not readily available or feasible, such as with installations on concrete or with chain-link fencing.

__________________ **7.** Round corner or end posts used with agricultural fencing are normally about ___″ in diameter.

__________________ **8.** A(n) ___ post is a fence member fixed firmly in an upright position and used to support a fence at a corner or end.

__________________ **9.** ___ are used when the ground does not allow sufficient penetration for a standard fence post.

__________________ **10.** A(n) ___ post is a fence post used as a part of a fence brace.

__________________ **11.** A(n) ___ wire is a fencing wire with high tensile strength made of high carbon steel.

__________________ **12.** A(n) ___ wire is a wire composed of two twisted steel strands with sharp two- or four-point barbs woven in along its length and spaced 4″ to 8″ apart.

__________________ **13.** A(n) ___ fence is a type of agricultural fence with metal wires that carry low amperage current and is used to control livestock.

__________________ **14.** A(n) ___ fence is a type of portable electric fencing composed of plastic mesh with energized electric strands woven through it.

__________________ **15.** ___ wire fabric is a type of fencing mesh with 2″ × 4″ openings and is used in areas where trespassers are likely.

__________________ **16.** ___ fences have fencing members that are not in tension, so they do not require fence braces.

__________________ **17.** A(n) ___ is a securely attached, movable barrier at an opening in a fence and is used to control access.

__________________ **18.** A(n) ___ is a device installed at an opening in a fence without a gate and allows easy vehicle access but prevents cattle from entering a specific area.

__________________ **19.** The NRCS and the ___ can provide recommendations for the installation of fences around bodies of water.

__________________ **20.** A(n) ___ is a long wooden or metal pole with marks spaced evenly at 2″ increments and is used for taking survey measurements.

Short Answer

1. Why are wood line posts preferred over metal line posts where livestock is contained?

2. What is an electric charger as used with agricultural fencing?

3. What is a wire fabric fence?

4. List five types of wire fabric fences that are used in agricultural applications.

5. List the procedure used to determine the degree of a ground slope when installing a fence.

Identification

Wire Fabric Fencing

Identify the types of wire fabric fencing.

______________ **1.** Chain-link fabric

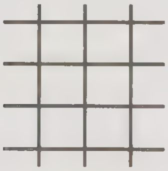
______________ **2.** Hardware cloth

______________ **3.** Poultry wire fabric

______________ **4.** No-climb wire fabric

______________ **5.** Welded wire fabric

______________ **6.** Woven wire fabric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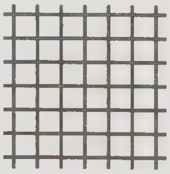
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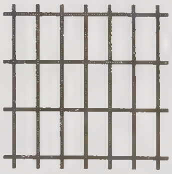
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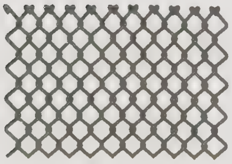
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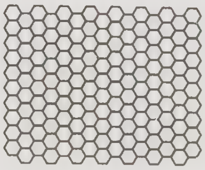
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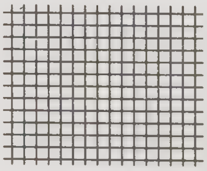
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Fence Gates

Identify the fence gate components.

_____ **1.** End post

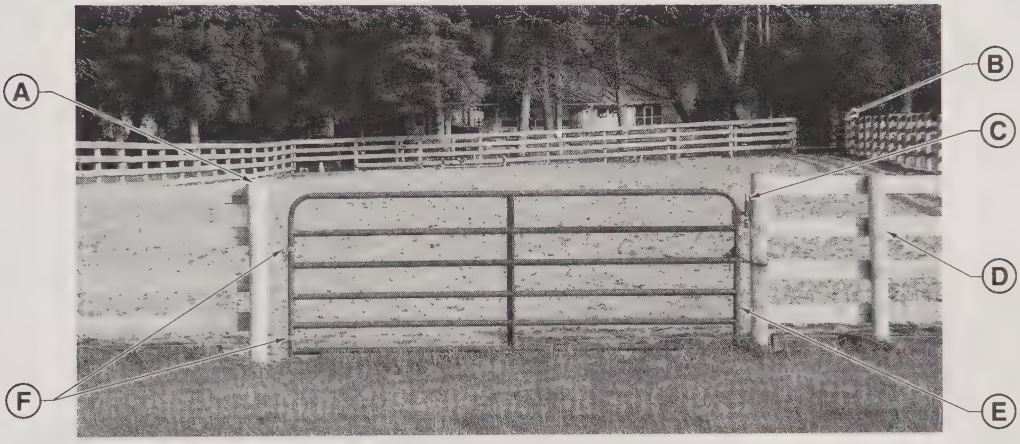
_____ **2.** Gate hinges

_____ **3.** Gate latch

_____ **4.** Gate with chain and lock

_____ **5.** Line post

_____ **6.** Rear gate



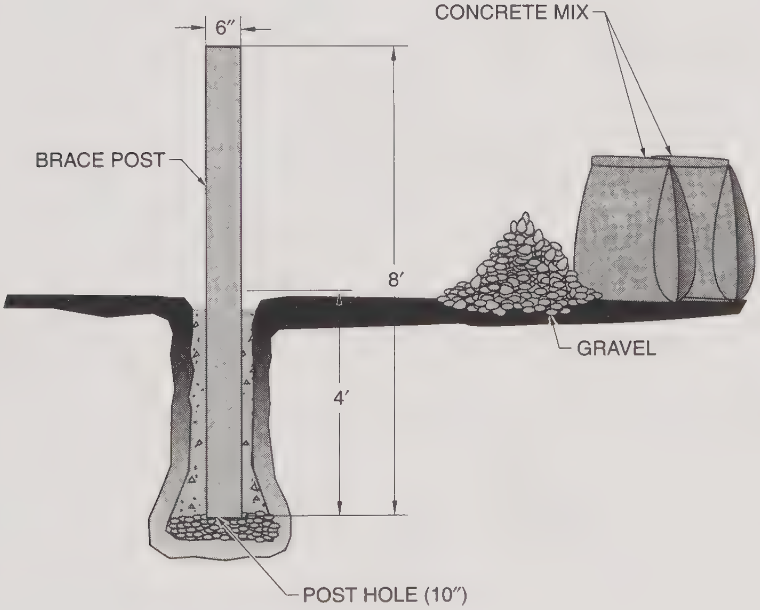
Fencing 15

Activities

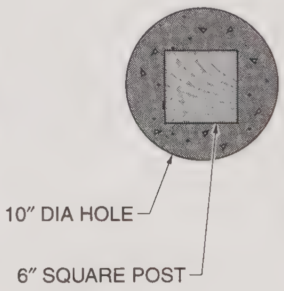
Name ______________________________ **Date** ____________________

Activity 15-1: Material Quantity Calculations for Brace Post Installation

1. Install a 6″ square, 8′ long post with a bury depth of 4′ in a 10″ diameter hole with a 6″ over dig. Back fill with alternating 6″ layers of gravel and bagged concrete mix. Calculate the amount of concrete mix and gravel needed for the backfill.


6″
CONCRETE MIX
BRACE POST
8′
GRAVEL
4′
POST HOLE (10″)

PROFILE VIEW


10″ DIA HOLE
6″ SQUARE POST

SECTION VIEW

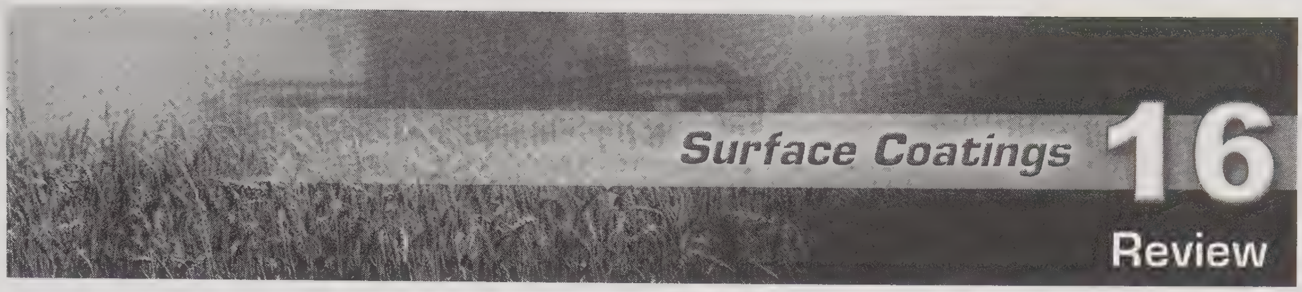
Activity 15-2: Fence Post Comparison

Insert a wood pencil and a section of wire of the same length cut from a clothes hanger into the ground at a depth of about half their lengths. Note: This activity is best performed on ground that is not frozen, rocky, or too dry.

1. Describe the difference in the force applied to insert the wire and the pencil into the ground.

2. Move the top of the pencil and wire in a sideways motion. Describe the difference in the force needed to move the pencil and the wire.

3. Describe how the force needed to move the wire and the pencil would compare to various types of fence posts.



Surface Coatings 16

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** Coatings are typically classified by the type of application that they are to be used for, such as primer, sealer, or topcoat, and as water-based or solvent-based.

T F **2.** Wax and glue can be considered volatile organic compounds (VOCs).

T F **3.** Oil-based coatings have a shorter dry time than water-based coatings.

T F **4.** An acrylic resin is a synthetic resin that dries to a hard finish and is chemical- and corrosion-resistant.

T F **5.** A topcoat is a final layer of coating applied to a surface for the purpose of improving appearance and/or performance.

T F **6.** Chemical cross-linking requires the blending of two materials (a two-component coating) and a digestion time before the coating is applied.

T F **7.** Solvent-based coatings are oven-dry type only.

T F **8.** Aerosol coating is considered environmentally friendly because there is very little waste since material from overspray can be reclaimed prior to curing.

T F **9.** Dry film thickness is the thickness of the resultant final mass of a coating application after the VOCs have evaporated.

T F **10.** Stain may be supplied in a gel form.

T F **11.** The main criteria for painting any bare wood surface are that the surface must be sufficiently dry and free from dirt, dust, and loose debris.

T F **12.** Most masonry coatings in agricultural applications are decorative rather than protective.

T F **13.** Metal surfaces can be categorized by their exposure conditions as severe, moderate, mild, and extremely mild.

T F **14.** Specialty coatings used in agriculture include asphalt coatings, aluminum coatings, and sealers.

T F **15.** Powder coating is a solvent-based coating that contains aluminum paste.

T F **16.** Shellac is used for interior and exterior applications where a hard, glossy, moisture-resistant finish is required.

T F **17.** When applying paint with a brush, a new brush stroke should always be started on an unpainted area and overlapped to finish on a painted area.

T F **18.** When applying paint with a roller, the smoother the finish required, the longer the nap length requirement on the roller cover.

T F **19.** The most common method used to paint large flat surfaces, such as walls, ceilings, floors, and panels, is by rolling the coating on the surface with a roller.

T F **20.** A jumbo roller has 9″ and 12″ widths and is suitable for painting large areas of most flat surfaces.

T F **21.** Airless pumps can be powered by hydraulic motors, compressed air, or electric motors.

T F **22.** Electrostatic spray paint systems allow for better surface penetration than other forms of spray painting, ensuring good adhesion and flow-out.

T F **23.** In agricultural applications, high-volume, low-pressure (HVLP) systems are only used to coat wood surfaces.

T F **24.** "Solids by volume" is a term used to indicate the coverage in square feet for a gallon of coating at a given dry film thickness.

T F **25.** The quantity of primer, paint, stain, or sealer is determined by calculating the area to be covered (in square feet) and dividing by the coverage per quart or gallon of material.

Multiple Choice

____________________ **1.** A(n) ___ resin is a synthetic binder resin commonly used in heat-cured coating systems.

A. alkyd
B. polyester
C. epoxy
D. urethane

____________________ **2.** The most common type of ___ coating systems are two-part systems where the resin and hardener are mixed together just prior to application.

A. latex
B. polyester
C. epoxy
D. urethane

____________________ **3.** A ___ is an initial coating applied to a surface to seal it before applying subsequent coats of another finish material.

A. primer
B. solvent
C. resin
D. sealer

______________ **4.** A ___ is a liquid or semiliquid material that forms an airproof or waterproof joint or coating.
A. primer
B. solvent
C. substrate
D. sealer

______________ **5.** An advantage of water-based coatings is ___.
A. reduced fire hazard
B. reduced chemical emissions from solvents
C. low toxicity
D. all of the above

______________ **6.** ___ is a highly viscous, flammable liquid obtained from petroleum distillation.
A. Mineral spirits
B. Resin
C. Shellac
D. all of the above

______________ **7.** The average coverage of one can of aerosol spray paint is typically about ___ sq ft.
A. 20
B. 40
C. 70
D. 100

______________ **8.** Aluminum coatings can reflect up to ___% of the sun's rays.
A. 25
B. 35
C. 50
D. none of the above

______________ **9.** ___ is a dark-colored pitch primarily composed of natural or synthetic hydrocarbon minerals.
A. Alkyd
B. Asphalt
C. Cement
D. Urethane

______________ **10.** Coatings that are formulated with ___ tend to fade and become chalky when exposed to sunlight.
A. alkyd
B. acrylic
C. latex
D. epoxy

______________ **11.** ___ is used as a surface-preparation coat to obtain an even tone on porous or soft wood such as pine.
- A. Varnish
- B. Enamel
- C. Shellac
- D. Solvent

______________ **12.** Never spray a coating in an area with an air temperature of ___°F or higher.
- A. 80
- B. 90
- C. 95
- D. 100

______________ **13.** ___ rollers are used when applying heavy coatings such as nonskid floor coatings.
- A. Plain core
- B. Jumbo
- C. Trayless
- D. Foam

______________ **14.** A(n) ___ spray paint system is a spray paint system that sprays coatings at reduced velocity for increased transfer efficiency.
- A. airless
- B. electrostatic
- C. high-volume, low-pressure (HVLP)
- D. all of the above

______________ **15.** Federal law was implemented in ___ to eliminate the use of lead-based coatings.
- A. 1971
- B. 1972
- C. 1973
- D. 1974

Completion

______________ **1.** A(n) ___ is a surface covering consisting of a pigment suspended in a vehicle of oil, solvent, water, or powder and used for decorative and/or protective purposes.

______________ **2.** A(n) ___ is an organic chemical compound that has high enough vapor pressure under normal conditions to vaporize and enter the atmosphere.

______________ **3.** A(n) ___ resin is a thermoplastic resin formed from esters of acrylic acid.

______________ **4.** A(n) ___ resin is a synthetic resin used in coating formulations to increase toughness, chemical resistance, abrasion resistance, and durability.

______________ **5.** A(n) ___-based coating is a coating in which water is the main solvent.

______________ **6.** A(n) ___ coating is made of a dispersion of fine particles of synthetic resin and pigment in water, is quick-drying, and is thinned with water.

______________________ **7.** ___ is a curing process in which curing is dependent on the molecular action between the coating and a hardener (curing compound).

______________________ **8.** A(n) ___ is a liquid used to dissolve other materials.

______________________ **9.** A(n) ___ coating is a coating packaged in a pressurized can with a nozzle designed to atomize the coating.

______________________ **10.** A(n) ___ is a pigmented wood finish used to seal wood while allowing the wood grain to be exposed.

______________________ **11.** A(n) ___ coating is a type of coating that contains a mix of portland cement and polymer for use as a coating and sealer on masonry surfaces.

______________________ **12.** ___ is metal that is coated with a thin layer of zinc for the purpose of inhibiting oxidation, rust, and corrosion.

______________________ **13.** A(n) ___ is a two-component pretreatment primer for use on properly prepared steel, aluminum, and galvanized metal.

______________________ **14.** ___ coating is an all-purpose coating formulated with varnish as the vehicle for aluminum-flake pigment.

______________________ **15.** Water-based coatings must be stored in an area where the temperature will not drop below 32°F or rise above ___°F.

______________________ **16.** When estimating volumetric coating requirement, a minimum of ___% is typically added to the final estimate to account for paint residue.

______________________ **17.** A(n) ___ is a fabric-covered cylinder that is attached to a handle with a rotating head and is used for painting.

______________________ **18.** A(n) ___ is a pneumatic tool in which compressed air is used to force surface coatings through a nozzle in a fine mist.

______________________ **19.** A(n) ___ spray paint system is a type of spray paint system that allows spray painting of high-viscosity coatings without the use of air pressure.

______________________ **20.** ___ spray painting is a coating application method for metal surfaces in which the metal surface to be painted is grounded or given a negative charge, and the coating is given a positive charge and atomized in specially designed equipment.

Short Answer

1. What is a resin as used with coatings?

2. List four advantages of solvent-based coatings.

3. How is powder coating applied?

4. What is the difference between asphalt coating and aluminum coating?

5. List the procedure to properly spray paint a primed surface.

Identification

Roller Types

Identify the types of rollers.

______________ **1.** Foam

______________ **2.** High-density

______________ **3.** Jumbo

______________ **4.** Narrow

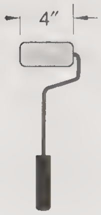
______________ **5.** Pipe

______________ **6.** Thin-line

______________ **7.** Tongs

______________ **8.** Touch-up

______________ **9.** Trayless



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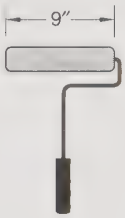

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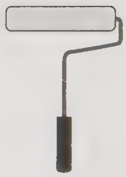
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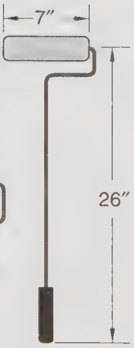

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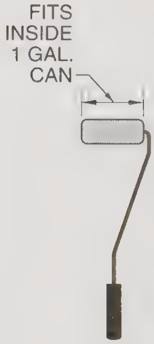
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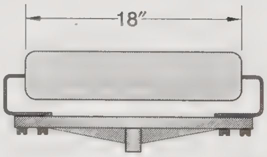

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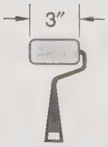

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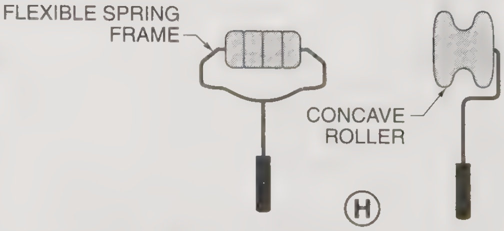
FLEXIBLE SPRING
FRAME
CONCAVE
ROLLER
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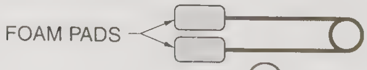

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Paint Spray Pattern Problems

Identify the causes of the different paint spray pattern problems. Note: Paint spray pattern problems may have more than one cause.

______________________ **1.** Air pressure too low

______________________ **2.** Air pressure too high

______________________ **3.** Damaged fluid nozzle

______________________ **4.** Excessive fluid velocity or too much fluid

______________________ **5.** Fluid buildup on one side of fluid nozzle

______________________ **6.** Fluid needle not seating (dirt)

______________________ **7.** Fluid pressure too low

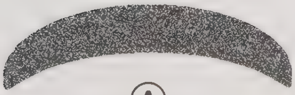
______________________ **8.** Loose fluid connection

______________________ **9.** Loose fluid nozzle

______________________ **10.** Loose or missing packing nut or dried fluid packing

______________________ **11.** One port of air nozzle clogged

______________________ **12.** Spray pattern too wide



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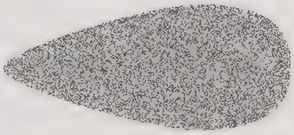

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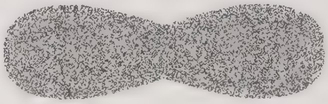

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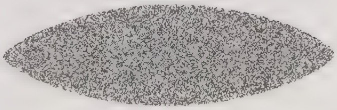

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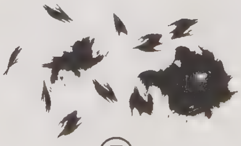

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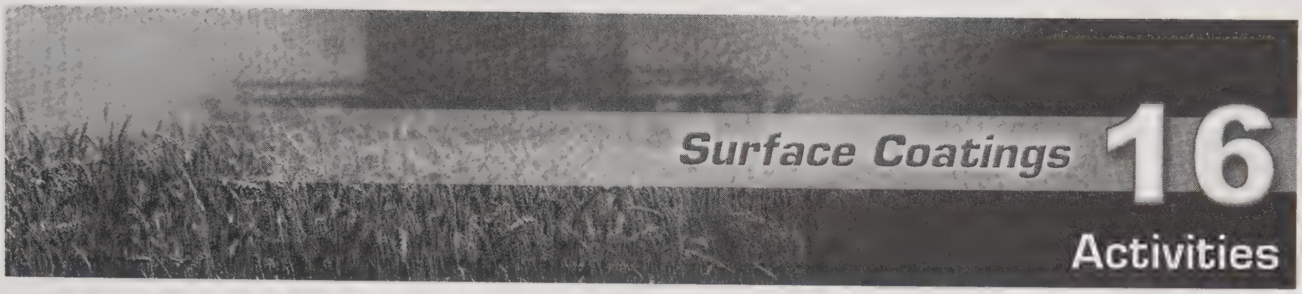


Surface Coatings 16

Activities

Name ________________________________ **Date** ____________________

Activity 16-1: Math Calculations

________________ **1.** $138 \times 21 =$ ___

________________ **2.** 1′-2″ + 3′-6″ + 10′-3″ = ___

________________ **3.** $\frac{5226}{26} =$ ___

________________ **4.** 13′-6″ – 10′-8″ = ___

________________ **5.** 36′-6″ – 18′-9″ = ___

________________ **6.** $\frac{536}{32} =$ ___

________________ **7.** $\frac{10}{16} = \frac{x}{88}$ (*solve for x*)

________________ **8.** $\frac{3}{8} + \frac{1}{2} + \frac{5}{16} =$ ___

________________ **9.** $\frac{3}{4} \times \frac{1}{2} =$ ___

________________ **10.** $\frac{12}{16} = \frac{x}{4}$ (*solve for x*)

________________ **11.** $\frac{5}{8} + 2 =$ ___

________________ **12.** $\frac{3}{4}$ of 3′ = ___

________________ **13.** $\frac{3}{5}$ of 15 = ___

________________ **14.** 75″ = ___′-___″

________________ **15.** 16′ ÷ 16″ = ___

________________ **16.** 7′-5″ + 21′-6″ + 13′-8″ = ___

________________ **17.** $12\frac{3}{4} + 5\frac{1}{8} + 16\frac{1}{2} =$ ___

________________ **18.** 18′-9″ – 12′-10″ = ___

________________ **19.** $\frac{3}{8} \times 12 =$ ___

________________ **20.** 3′-6″ + 13′-4″ + 2′-11″ = ___

Activity 16-2: Environmental Conditions

The amount of time required for coatings to dry and become fully cured is dependent on environmental factors such as air temperature and humidity. Most coatings manufacturers list a preferred temperature range for application on the container label.

Apply a coating of latex house paint to a section of plywood or drywall as close to each of the following conditions as possible and note the differences in ease of application and the amount of time required for the paint to become dry to the touch. Note: Use the same type of coating for each test. Consult the manufacturer's container label for proper PPE usage.

1. Air temperature: 70°F – 75°F
Relative humidity: 65% ±5%

2. Air temperature: 50°F – 55°F
Relative humidity: 80% ±5%

3. Air temperature: 85°F – 90°F
Relative humidity: 90% or higher

4. Air temperature: 60°F – 65°F
Relative humidity: 80% ±5%

5. Air temperature: 50°F – 55°F
Relative humidity: 50% ±5%

Activity 16-3: Gloss Level

The gloss level of a topcoat finish is affected by the gloss level of the substrate it is applied to.

Use a satin, flat, or eggshell finish topcoat and apply evenly to the following substrates (or similar) and note differences in gloss level after the topcoat has completely dried. Note: Use a compatible coating for each type of substrate. Consult the manufacturer's container label for proper PPE usage.

1. Unpainted drywall

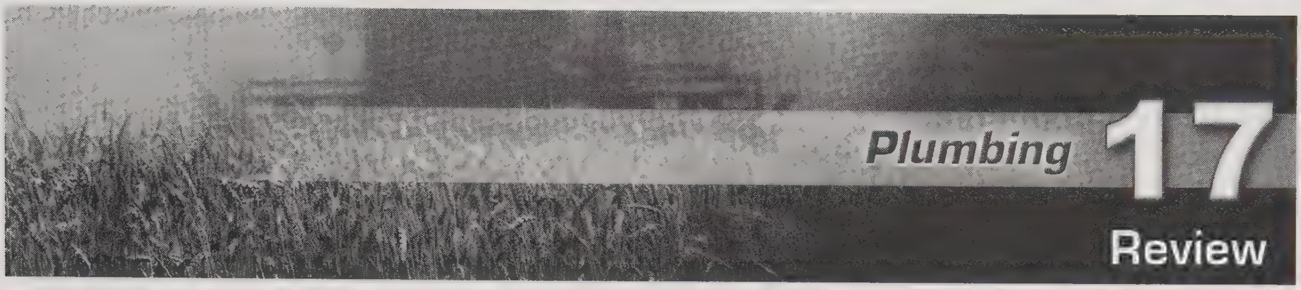
2. Unpainted steel sheet metal

3. Primed steel sheet metal

4. Primed aluminum

5. Unpainted lumber

6. Lumber coated with high-gloss topcoat



Plumbing 17

Review

Name ______________________________ Date ____________________

True-False

T F **1.** Hand injuries are the most common injuries that occur when performing plumbing operations.

T F **2.** A model plumbing code is a plumbing code developed by a regional committee of code enforcement officials.

T F **3.** A septic system is a system of pipes, fittings, and devices within a building.

T F **4.** An interceptor, or separator, is a device designed and installed to separate, retain, and treat deleterious, hazardous, and undesirable matter before the matter enters the sewer system.

T F **5.** A front main cleanout is a capped or plugged fitting located near the front wall of a building where the building drain exits the building beginning at least 1′ outside the foundation footings.

T F **6.** Potable water is water that is to be treated to remove impurities that could cause disease or harmful physiological effects.

T F **7.** Local plumbing codes are based on local conditions such as soil types, ground conditions, local rainfall, and frost or freezing conditions.

T F **8.** Copper is the most commonly used material for plumbing pipe and fittings.

T F **9.** Polyvinyl chloride pipe and fittings are the most commonly used type in the plumbing industry.

T F **10.** A firestop is a material or member that seals open construction to inhibit the spread of fire.

T F **11.** A seamless pipe is steel pipe manufactured by drawing flat steel strips through a die to form a cylindrical shape and then electric butt-welding the seam to create a leakproof joint.

T F **12.** Valve bodies are available in cast bronze only.

T F **13.** A control valve is a valve designed to be used in its fully open or fully closed position.

T F **14.** There are three stem and screw configurations that are available for gate valves.

T F **15.** A spilt-wedge-disk gate valve is a gate valve in which the threaded stem of the valve rises as the valve is opened.

T F **16.** Globe valves are rated or nonrated, depending on the application.

T F **17.** A ball valve is a valve in which fluid flow is controlled by a ball that fits tightly against a resilient (pliable) seat in the valve body.

T F **18.** A swing check valve is a check valve in which backflow is prevented through the use of a disk that moves vertically within the valve body.

T F **19.** Backwater flow valves are used to either relieve temperature and pressure or for pressure relief only.

T F **20.** Water meters measure and indicate water usage for a building so that the building owner can be charged for the amount of water used by the water utility or supplier.

T F **21.** The most common specialty tools used for agricultural installations include plastic pipe saws and cutters, plastic pipe deburring tools, copper tubing cutters, and copper tube deburring tools.

T F **22.** Well pumps provide space to accept the desired usable water volume, which in turn maintains proper run-time on the septic tank.

T F **23.** Septic systems are used in agricultural applications for removal of wastewater from small buildings that do not have access to municipal sewer systems.

T F **24.** The three naturally occurring layers in a septic tank are the water layer, the solid layer, and the scum layer.

T F **25.** A gas piping system supplies natural gas from the gas main to the building supply main for distribution to gas appliances.

T F **26.** An appurtenance is a structural portion of a building that is built-in.

T F **27.** Plastic pipe and fittings have good heat resistance.

T F **28.** Black steel pipe is coated with varnish.

T F **29.** Schedule 40 steel pipe is thicker than Schedule 80 pipe.

T F **30.** Plumbing work is rarely, if ever, performed near energized electrical equipment.

Multiple Choice

______________ **1.** A ___ is piping that conveys potable water for public or community use from a municipal water supply source or a well.
- A. fixture branch
- B. water main
- C. vent pipe
- D. water distribution pipe

______________ **2.** PVC pipe up to ___″ in diameter is available for use in underground drainage piping.
- A. 8
- B. 10
- C. 12
- D. 16

______________ **3.** A ___ is a soil or waste pipe that receives only the discharge from fixtures on the same floor as the branch and extends horizontally from a stack.
- A. horizontal branch
- B. fixture branch
- C. soil stack
- D. waste stack

______________ **4.** A ___ system is a system that includes a water service pipe, water distribution pipes, branch and supply pipes, fittings, and water meter valves.
- A. septic
- B. sanitary sewer
- C. stormwater drainage
- D. potable water supply

______________ **5.** ___ pipe is black plastic pipe used for sanitary drainage and vent piping or aboveground and underground stormwater drainage.
- A. Polyvinyl chloride (PVC)
- B. Acrylonitrile-butadiene-styrene (ABS)
- C. Chlorinated polyvinyl chloride (CPVC)
- D. Cross-linked polyethylene (PEX)

______________ **6.** ___ is a material commonly used for potable water distribution, corrosive industrial fluid handling, and fire suppression systems.
- A. Polyvinyl chloride (PVC)
- B. Acrylonitrile-butadiene-styrene (ABS)
- C. Chlorinated polyvinyl chloride (CPVC)
- D. Black pipe

______________ **7.** ___ pipe is cleaned and dipped into a hot (870°F) molten zinc bath to create a protective coating.
- A. Galvanized
- B. Cast copper
- C. Black
- D. Aluminum-coated

______________ **8.** A ___ is a fitting used to regulate fluid flow within a system.
A. valve
B. pipe
C. pressure gauge
D. core cock

______________ **9.** A ___ valve is a valve used to control fluid flow by means of a pliable, circular disk that is compressed against a valve seat surrounding the opening through which water flows.
A. gate
B. butterfly
C. globe
D. ball

______________ **10.** A ___ valve is a valve used to control fluid flow using a rotating disk that seats against a resilient material within the valve body.
A. globe
B. check
C. relief
D. butterfly

______________ **11.** A ___ valve is a safety device that is activated to open when pressure or temperature in a closed plumbing system exceeds safe operating limits.
A. check
B. relief
C. gate
D. globe

______________ **12.** ___ valves have a solid- or split-wedge disk.
A. Gate
B. Ball
C. Globe
D. Core cock

______________ **13.** A(n) ___ is a test device used to measure the pressure within waste and vent, water, gas, air, or other piping systems to ensure the system is maintaining the proper pressure.
A. inflatable test plug
B. manometer
C. test gauge assembly
D. mechanical test plug

______________ **14.** The type of ___ system installed depends upon the topography of the site, geographical location, soil porosity, groundwater elevations, and the system location with relation to streams, wells, property lines, water lines, and other factors.
A. livestock water
B. septic
C. stormwater drainage
D. potable water supply

______________ **15.** A(n) ___ is the portion of gas piping that supplies gas to various appliances throughout a building.
   A. building supply main
   B. gas pipe drop
   C. gas pipe riser
   D. individual vent pipe

Completion

______________ **1.** A(n) ___ pipe is a pipe that conveys water from a water service pipe to the point of use.

______________ **2.** A(n) ___ is a fitting with a removable cap or plug installed in a sanitary drainage pipe to allow access to the pipe for removing stoppages and cleaning the interior of the pipe.

______________ **3.** A(n) ___ is a vertical drainage pipe that extends through one or more floors and receives the discharge of fixtures other than water closets and urinals.

______________ **4.** A(n) ___ is a pipe that vents an individual fixture trap and may terminate into a branch vent, stack vent, vent stack, or the open air.

______________ **5.** A(n) ___ system is a piping system used to convey rainwater or other precipitation to a storm sewer or other place of disposal.

______________ **6.** A(n) ___ fitting is a pipe fitting in which all openings have the same dimension.

______________ **7.** ___ is rigid plastic material used for waterstops, sanitary drainage and vent piping, aboveground and underground stormwater drainage, water mains, and water service lines.

______________ **8.** ___ is a thermosetting plastic made from medium or high-density cross-linkable polyethylene and is used for water service piping and cold and hot water distribution piping.

______________ **9.** A(n) ___ nipple is a nipple that is threaded its entire length.

______________ **10.** A(n) ___ valve is a valve designed to control fluid flow rate by partially opening or closing.

______________ **11.** A(n) ___ valve is a full-way valve that uses a threaded stem to raise and lower a wedge-shaped disk that fits against a smooth machined surface, or valve seat, within the valve body in order to regulate fluid flow.

______________ **12.** A(n) ___ gate valve is a gate valve in which the handwheel and the stem do not rise when the valve is opened.

______________ **13.** A(n) ___ is a globe valve in which the valve seat diameter is less than the stated size of the valve.

______________ **14.** A(n) ___ is a valve with integral external threads installed on the exterior of a building for the attachment of a hose.

______________ **15.** A(n) ___ is a valve with hose threads and is installed on a tank, such as a water heater, to drain and/or flush the tank.

______________ **16.** A(n) ___ is a valve through which water or gas flow is controlled by a circular core or plug that fits closely in a machined seat.

______________ **17.** A(n) ___ check valve is a check valve in which backflow is prevented through the use of a hinged disk within the valve body.

______________ **18.** A(n) ___ backwater valve is a backwater valve that acts as a check valve and has a hinged flap or disk that swings open to permit drain flow in the desired direction.

______________ **19.** A(n) ___ valve is a safety device used to protect against excessive temperature and/or pressure in a water heater.

______________ **20.** A(n) ___ test plug is a test plug that is inserted into pipe during an air or water test and secured in position by inflating the plug with air.

______________ **21.** A(n) ___ is the drainage pipe that extends from the trap of a fixture to the junction of the next drainage pipe.

______________ **22.** ___ piping systems can have plastic pipe that is yellow or black with yellow stripes.

______________ **23.** The maximum developed length of rigid plastic drainage, waste, and vent piping, including ABS and PVC DWV pipe, is ___′.

______________ **24.** Valves with hose threads, including sillcocks, must be installed with a(n) ___ to prevent back siphonage.

______________ **25.** A(n) ___ valve is used to prevent the backflow of sewage into a building.

Short Answer

1. What are the four classifications of plumbing pipe and fitting materials?

2. List ten types of valves used in plumbing and plumbing-related systems.

3. List the three stem and screw configurations that are available for gate valves.

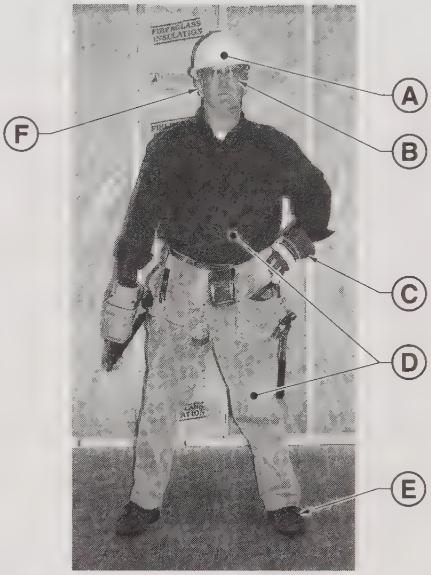
4. What is a septic system?

5. Explain the difference between a gas pipe drop and a gas pipe riser.

Identification

Standard PPE

Identify the standard PPE worn when performing plumbing work.


A
B
C
D
E
F
FIBERGLASS INSULATION

______________ **1.** Earplugs

______________ **2.** Gloves

______________ **3.** Protective helmet

______________ **4.** Safety glasses

______________ **5.** Safety shoes

______________ **6.** Sturdy clothing

Plastic Pipe Identification

Identify the standard plastic pipe markings.

______________ **1.** Laboratory seal

______________ **2.** Manufacturer trademark

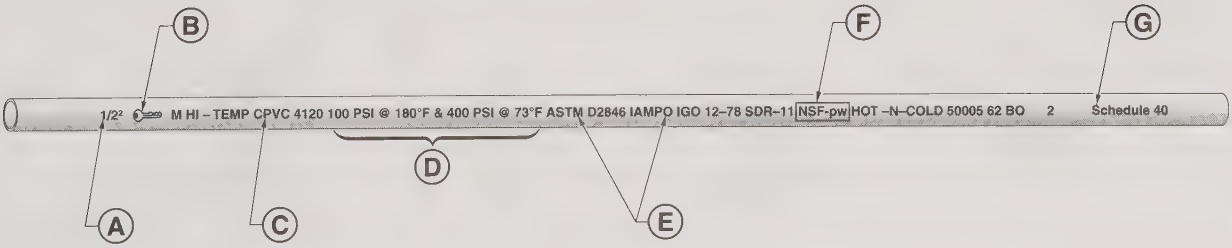
______________ **3.** Pipe schedule

______________ **4.** Pipe size

______________ **5.** Pressure rating

______________ **6.** Recognized standardization authorities

______________ **7.** Resin type


B
F
G
1/2²
M HI – TEMP CPVC 4120 100 PSI @ 180°F & 400 PSI @ 73°F ASTM D2846 IAMPO IGO 12–78 SDR–11 NSF-pw HOT –N–COLD 50005 62 BO 2 Schedule 40
D
A
C
E

Sanitary Drainage and Vent Piping Systems

Identify the sanitary drainage and vent piping system components.

______________________ **1.** Floor drain

______________________ **2.** Loop vent

______________________ **3.** Roof vent

______________________ **4.** Soil pipe

______________________ **5.** Stack cleanout

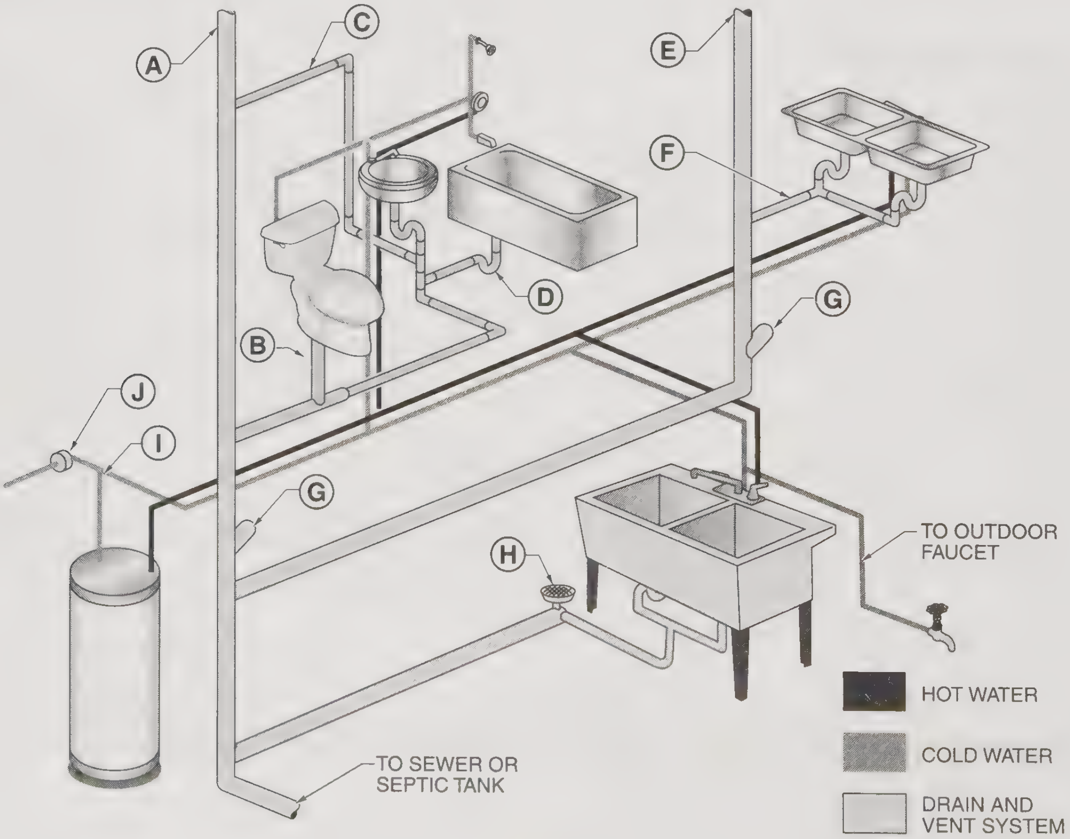
______________________ **6.** Stack vent

______________________ **7.** Trap

______________________ **8.** Waste pipe

______________________ **9.** Water meter

______________________ **10.** Water supply


A
C
E
F
D
G
B
J
I
G
H
TO OUTDOOR FAUCET
TO SEWER OR SEPTIC TANK
HOT WATER
COLD WATER
DRAIN AND VENT SYSTEM

ABS DWV Fittings

Identify the ABS DWV fittings.

__________ **1.** Adapter (male)

__________ **2.** Adapter (female)

__________ **3.** Bushing

__________ **4.** Cap

__________ **5.** Cleanout adapter

__________ **6.** Closet flange

__________ **7.** Coupling

__________ **8.** Double sanitary tee

__________ **9.** 45° elbow

__________ **10.** 45° street elbow

__________ **11.** 45° double wye

__________ **12.** 45° wye

__________ **13.** Long-radius T-Y

__________ **14.** Long-turn 90° elbow

__________ **15.** 90° elbow

__________ **16.** 90° street elbow

__________ **17.** Sanitary tee

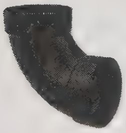
__________ **18.** 60° elbow

__________ **19.** Test tee

__________ **20.** Trap adapter

__________ **21.** 22½° street elbow

__________ **22.** 22½° elbow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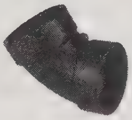
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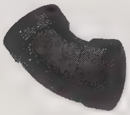
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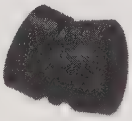
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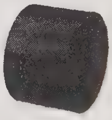
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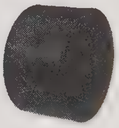
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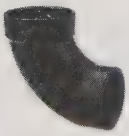
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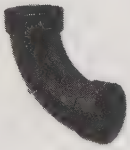
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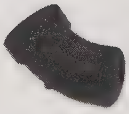
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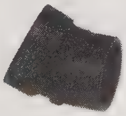
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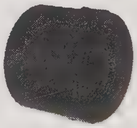
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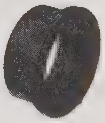
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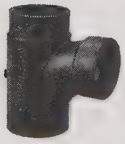
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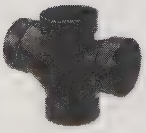
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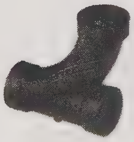
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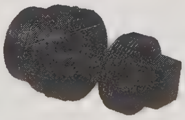
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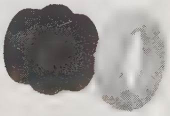
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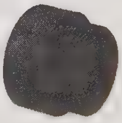
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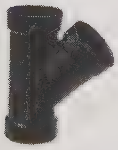
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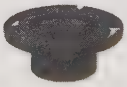
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NIBCO, Inc.

PEX Fittings

Identify the PEX fittings.

__________ **1.** Adapter (PEX × copper solder)

__________ **2.** Adapter (PEX × male iron pipe thread)

__________ **3.** Branch manifold

__________ **4.** Coupling

__________ **5.** 90° drop ear elbow

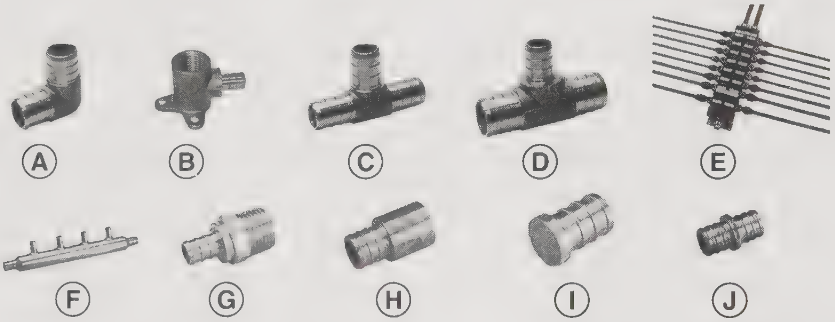
__________ **6.** 90° elbow

__________ **7.** Plug

__________ **8.** Primary manifold

__________ **9.** Reducing tee

__________ **10.** Tee



Vanguard Piping Systems, Inc.

Private Sewage Disposal Systems

Identify the private sewage disposal system components.

__________ **1.** Absorption field

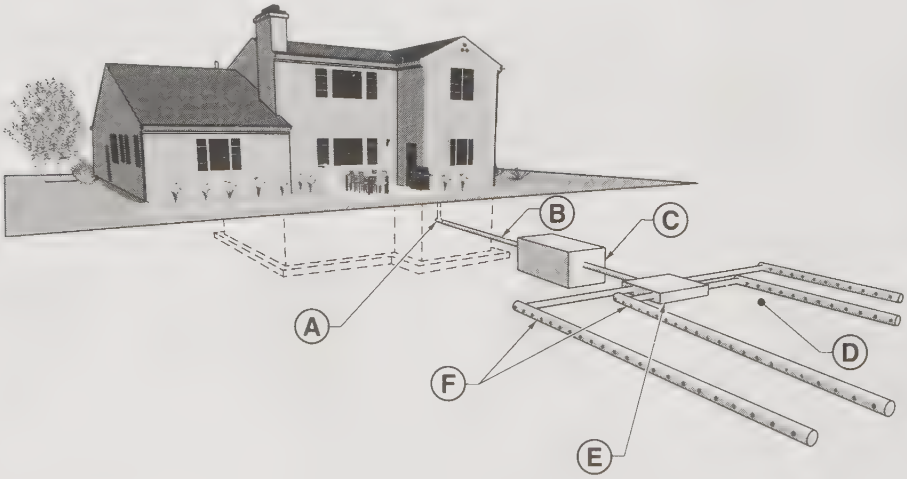
__________ **2.** Cleanout

__________ **3.** Distribution box

__________ **4.** House sewer

__________ **5.** Perforated pipes

__________ **6.** Septic tank



Specialty Plumbing Tools

Identify the specialty plumbing tools.

______________________ **1.** Chop saw

______________________ **2.** Cone-type plastic pipe deburring tool

______________________ **3.** Cone-type copper tubing deburring tool

______________________ **4.** Copper tubing cutter – external

______________________ **5.** Copper tubing cutter – internal

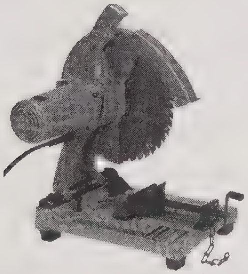
______________________ **6.** Internal plastic pipe cutter

______________________ **7.** Pencil-type plastic pipe deburring tool

______________________ **8.** PVC/ABS saw

______________________ **9.** Ratchet-type plastic pipe cutter

______________________ **10.** Scissors-type plastic pipe cutter


Milwaukee Electric Tool Corp.

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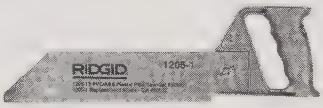

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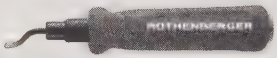

Rothenberger USA, Inc.

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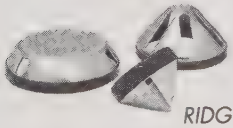
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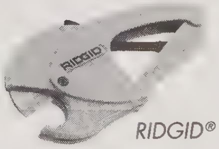

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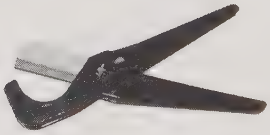
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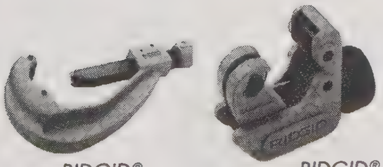

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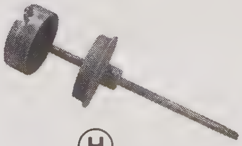
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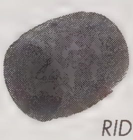
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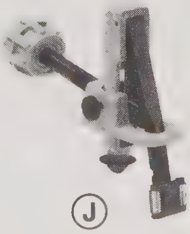
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Septic Tanks

Identify the septic tank components and contents.

______________ 1. Access covers

______________ 2. Baffle

______________ 3. Effluent

______________ 4. Flow direction

______________ 5. Inlet

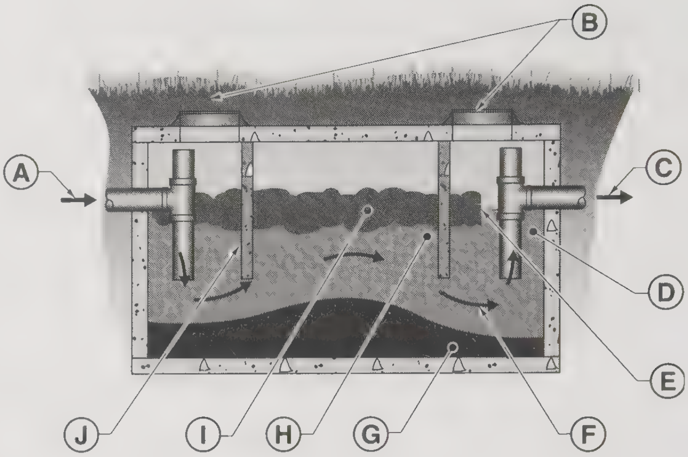
______________ 6. Liquid layer

______________ 7. Outlet

______________ 8. Scum layer

______________ 9. Sludge layer

______________ 10. Static water level



LP Gas Systems

Identify the LP gas system components.

______________ 1. Buried gas piping

______________ 2. Emergency evacuation fitting

______________ 3. Filler valve

______________ 4. First-stage regulator

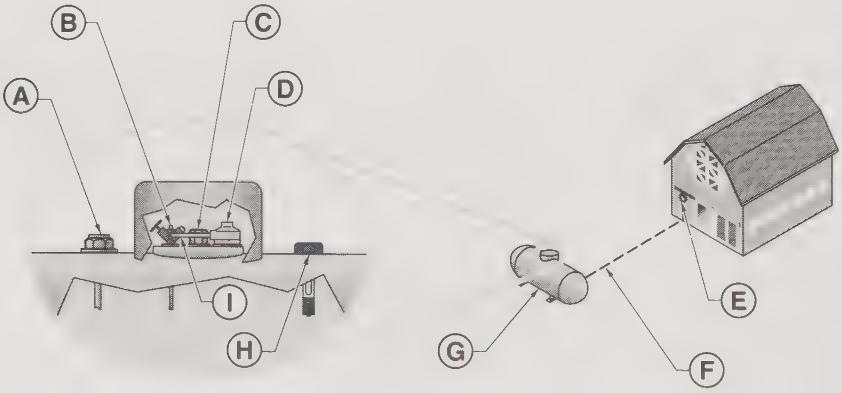
______________ 5. LP tank

______________ 6. Multivalve

______________ 7. Pigtail

______________ 8. Pressure-relief valve

______________ 9. Second-stage regulator



Plumbing 17

Activities

Name ______________________________ **Date** ____________________

Activity 17-1: Effective Planning

Planning is essential to the efficient installation of piping materials, regardless of the type of pipe and fittings being installed. One element of good planning is ensuring that the proper tools and equipment are available for performing an operation.

Plan for the following piping operations.

1. Given a 20′ length of 4″ ABS DWV pipe, list the tools and equipment required to measure, mark, cut, and prepare three 5′ sections for use.

2. Given a 5′ length of 4″ double-hub cast iron soil pipe, list the tools and equipment required to measure, mark, cut, and prepare two 2′-6″ sections for use.

3. Given a 21′ length of steel pipe, list the tools and equipment required to manually cut and thread the pipe.

Activity 17-2: Weight of Water in Pipes

Regardless of the pipe material, the weight of water in a pipe should be known before removing hangers or other supports when repairing plumbing systems. The weight of water is calculated using the following formula:

$$weight = 0.34d^2 \times l$$

where

$weight$ = weight of water (in lb)
0.34 = constant
d = diameter of pipe (in in.)
l = length of pipe (in ft)

Determine the weight of water contained in the following sections of pipe.

____________ **1.** 4″ diameter × 10′ long

_________________ **2.** 2″ diameter × 5′ long

_________________ **3.** 8″ diameter × 12′ long

_________________ **4.** 1¼″ diameter × 6′ long

_________________ **5.** 2½″ diameter × 18′ long

Activity 17-3: Calculating Grade, Fall, and Run

Drainage piping grade calculations are frequently used on a plumbing job. Grade is the slope of a horizontal run of pipe and is expressed as a fractional inch per foot length of pipe. Fall is the distance the drainage pipe drops in its given length and is expressed in inches. Run is the horizontal distance the pipe covers and is expressed in feet.

Grade is calculated by dividing the fall by the run ($G = F \div R$). Fall is calculated by multiplying the run by the grade ($F = R \times G$). Run is calculated by dividing the fall by the grade ($R = F \div G$).

Determine the unknown value for each of the following.

_________________ **1.** Grade of a 200′ run of pipe that falls 50″

_________________ **2.** Fall of a 75′ run of pipe that is graded at ⅛″ per foot

_________________ **3.** Run of a pipe that falls 22″ and is graded at ¼″ per foot

_________________ **4.** Fall of a 125′ run of pipe that is graded at ¼″ per foot

_________________ **5.** Grade of a 50′ run of pipe that falls 12½″

_________________ **6.** Run of a pipe that falls 45″ and is graded at ⅛″ per foot

_________________ **7.** Fall of a 75′ run of pipe that is graded at ¼″ per foot

Activity 17-4: Plumbing Resources

1. Tools and equipment are typically available in several models and levels of quality to appeal to consumers and professionals. In general, professional-grade tools and equipment have greater durability and reliability than consumer-grade tools. Obtain tool and equipment manufacturer catalogs or visit their websites and compare and contrast specifications of common professional-grade and consumer-grade tools and equipment.

2. Several companies specialize in tools and equipment used in the plumbing trade. Contact tool and equipment manufacturers to request literature regarding their products. Review the product literature and compare and contrast the features of the tools and equipment. Develop a list of tools and equipment that an agricultural mechanic might purchase to perform basic plumbing operations.

3. Obtain a set of prints for an agricultural building. Identify the plumbing fixtures and appliances to be installed in the building. Determine the types and sizes of traps to be used in the building.

Irrigation 18

Review

Name ______________________________ Date ________________

True-False

T F 1. Water is the most common natural resource on earth.

T F 2. Evapotranspiration is the passage of moisture from living plant membranes or animal pores into vapor.

T F 3. As precipitation collects on the earth surface, most of it evaporates.

T F 4. Groundwater is water within the soil pore space near the surface that is available to support plants.

T F 5. A tensiometer is an instrument that is used for measuring the quantity of precipitation.

T F 6. Precipitation is the result of the evaporation and evapotranspiration of moisture that stays in the lower atmosphere.

T F 7. Light-colored soil is usually an indication of productive soil.

T F 8. Most types of soil will freely provide up to half of its moisture to plants.

T F 9. The simplest method of determining soil moisture content is the checkbook method.

T F 10. Tensiometer readings are taken and recorded monthly to track soil moisture.

T F 11. Irrigation must be terminated prior to the start of crop harvesting.

T F 12. Irrigation is the artificial application of water to the land for the purpose of growing and maintaining agricultural crops and landscape.

T F 13. An aqueduct is a barrier or structure across a stream, river, or waterway built for the purpose of controlling the flow of water.

T F 14. The maximum available soil moisture is determined by taking a soil moisture reading after total soil saturation and surface water has runoff.

T F 15. Surface irrigation is the aerial application of water through sprinklers placed along a water supply pipe.

T F 16. A vane pump is a pump that is used to move large volumes of liquid.

T F **17.** A common type of surface irrigation is ditch irrigation, in which water is provided to crops through furrows (ditches) placed between crop rows.

T F **18.** Flood irrigation systems include basin, border strip, and furrow irrigation.

T F **19.** Basin irrigation is the most efficient surface irrigation method with typical efficiencies in the range of 80% to 90%.

T F **20.** Furrow irrigation is the least efficient surface irrigation method with an efficiency range of 20% to 34%.

T F **21.** Subsurface irrigation systems that deliver water directly to plants just above or below the soil surface are the most efficient method of irrigation.

T F **22.** Modern rainwater harvesting systems are used to provide collected rainwater for the purpose of irrigating crops, provide drinking water, and provide water for underground wells.

T F **23.** Rainwater harvesting systems can be passive or active.

T F **24.** A simple gravity system is composed of a storage tank, a valve, a bucket, hoses, and drip lines to move collected water.

T F **25.** Harvested rainwater is rarely contaminated.

Multiple Choice

________________ **1.** ___ is the depositing of water on the earth in any form, such as rain, snow, sleet, hail, or mist.

A. Evaporation
B. Precipitation
C. Transpiration
D. Infiltration

________________ **2.** ___ is the conversion of water into vapor.

A. Evaporation
B. Precipitation
C. Transpiration
D. Infiltration

________________ **3.** ___ is the portion of precipitation that is not absorbed by the surface of land and collects, flows downward, and eventually reaches a body of water or a sewer.

A. Accumulation
B. Dew
C. Runoff
D. Water vapor

______ **4.** ___ is the amount of moisture or water vapor in the atmosphere.
A. Dew
B. Condensation
C. Relative humidity
D. Precipitation

______ **5.** A(n) ___ is a water-bearing stratum of permeable sand, gravel, or rock.
A. aquifer
B. aqueduct
C. dam
D. aquaculture system

______ **6.** In the ___ method of soil moisture testing, the initial soil moisture content is evaluated daily during planting season.
A. pan evaporation
B. checkbook
C. tensiometer
D. manual test

______ **7.** A ___ is a sealed water-filled tube with a porous tip on the bottom and a vacuum gauge mounted on top to measure the suction necessary to remove moisture from the soil at the depth of the porous tip.
A. displacement meter
B. water flow meter
C. rain gauge
D. tensiometer

______ **8.** For proper growth, corn typically requires moisture in the soil at depths between ___″ to ___″ during the growing season.
A. 10; 12
B. 18; 22
C. 20; 25
D. 24; 36

______ **9.** A(n) ___ is a structure used to transport water above or below ground.
A. aquifer
B. aqueduct
C. dam
D. aquaculture system

______ **10.** Soil salinity is the measurement of the accumulation of ___ found in soil.
A. clay
B. mineral salts
C. metals
D. sand

____________________ **11.** ___ sprinkler systems can automatically move to expand the coverage area and were originally powered by the force of the pumped water.

A. Fixed
B. Self-propelled
C. Passive
D. Active

____________________ **12.** With ___ irrigation, water is applied to a level area enclosed by some type of earthen border, which may be permanent or temporary.

A. basin
B. border strip
C. furrow
D. trickle

____________________ **13.** ___ irrigation systems are used in areas with a high water table or where drainage is needed during parts of the year to remove excess groundwater.

A. Subsurface
B. Surface
C. Trickle
D. Sprinkler

____________________ **14.** A typical application for a trickle irrigation system would be the irrigation of a crop such as ___.

A. corn
B. wheat
C. soybeans
D. lettuce

____________________ **15.** The three main parts of a(n) ___ system are rain, collection devices, and an application method.

A. passive rainwater harvesting
B. active rainwater harvesting
C. irrigation
D. soil testing

Completion

____________________ **1.** The ___ is the sequence of conditions that water passes through, starting as vapor in the atmosphere, then becoming precipitation, and then returning to the atmosphere as a result of evaporation and transpiration.

____________________ **2.** ___ is the loss of water from the soil by evaporation and from plants and animals by transpiration.

____________________ **3.** ___ is the process of one substance passing or filtering through another substance.

____________________ **4.** ___ is water within the earth that supplies wells and springs.

____________________ **5.** ___ is water falling to the earth in the form of drops of condensed vapor from the atmosphere.

______________ **6.** The ___ is a government agency that provides detailed soil classification and soil type maps to support agriculture.

______________ **7.** ___ is the lowering of the groundwater surface level caused by pumping water from a well.

______________ **8.** ___ is a soil test method that uses a standard-size pan to measure the water evaporation rate and is correlated to the evapotranspiration rate of crops by use of crop coefficients.

______________ **9.** ___ is the artificial application of water to the land to provide adequate moisture for the growth of crops and vegetation.

______________ **10.** A(n) ___ is a public corporation created under the authority of a state government having power to obtain and distribute water for irrigation of lands within the district.

______________ **11.** ___ is the wearing away of the soil surface through physical removal caused by water or wind.

______________ **12.** ___ sprinkler systems use a lateral pipeline with sprinkler heads installed at regularly spaced intervals.

______________ **13.** A(n) ___ pump is a type of pump that draws fluid into the center of a rapidly spinning impeller and discharges it using pressure created by centrifugal force created by the impeller.

______________ **14.** ___ is the amount of fluid pressure between points at different elevations, such as in a column or vertical pipe.

______________ **15.** ___ sprinklers are evenly spaced on stationary platforms and pumped to deliver water at a lower rate than the soil infiltration rate so water is evenly applied to the crops.

______________ **16.** A(n) ___ irrigation system is an irrigation system where water is delivered to a field in a ditch, pipe, or other means and flows over the ground to crops.

______________ **17.** ___ irrigation systems are flood irrigation systems that consists of land formed into narrow, downward-sloping strips with ridges or small berms as boundaries.

______________ **18.** ___ irrigation is an irrigation method of water distribution in which water is slowly applied through emitters placed along a water supply pipe near the soil surface.

______________ **19.** A(n) ___ system is a system that accumulates and stores rainwater for future use such as irrigation and watering.

______________ **20.** A(n) ___ rainwater harvesting system is a rainwater harvesting system where rainwater is captured, stored, and later transported by other means to a desired application area.

Short Answer

1. What forms does precipitation take?

2. Which states in the U.S. commonly use irrigation districts to distribute and manage water resources for agricultural use?

3. What is the difference between the maximum available soil moisture and the lack of soil moisture?

4. List and describe the types of flood irrigation systems.

5. Briefly explain the difference between a passive rainwater harvesting system and an active rainwater harvesting system.

Identification

Aqueducts

Identify the aqueduct components.

______________ **1.** Conduit

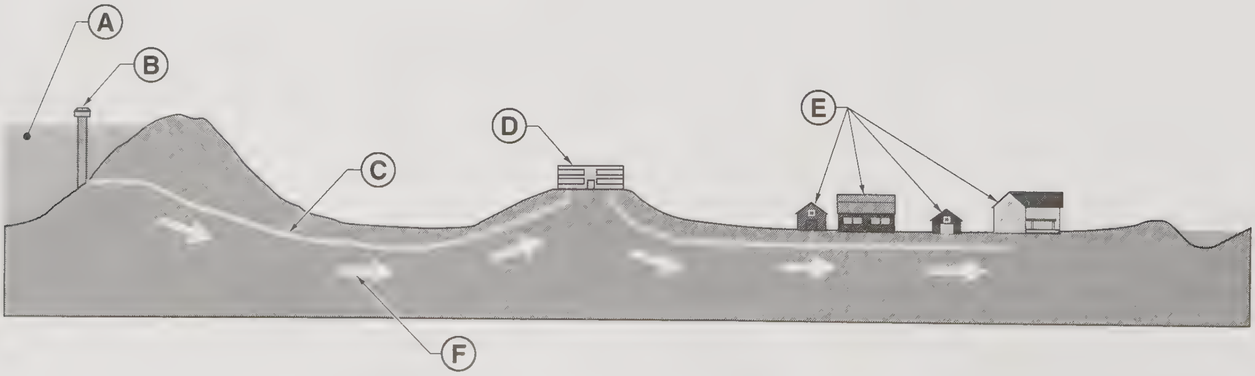
______________ **2.** Direction of water flow

______________ **3.** End users

______________ **4.** Intake

______________ **5.** Reservoir

______________ **6.** Treatment plant



Irrigation Systems

Identify the different types of irrigation systems. Note: Systems may be shown more than once.

______________ **1.** Basin

______________ **2.** Border strip

______________ **3.** Center-pivot sprinkler

______________ **4.** Drip

______________ **5.** Furrow

______________ **6.** Hose-pull traveler

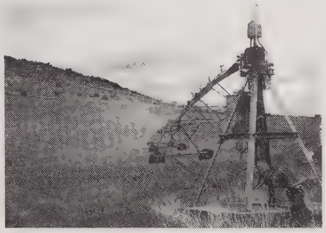
______________ **7.** Lateral pipe

______________ **8.** Self-propelled sprinkler

______________ **9.** Subsurface

______________ **10.** Trickle

______________ **11.** Wheel line



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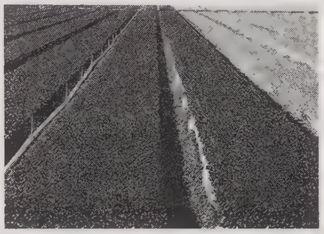

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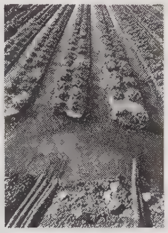

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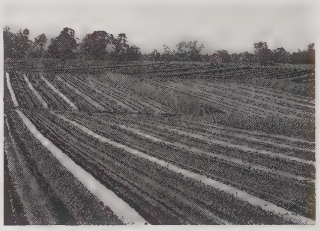

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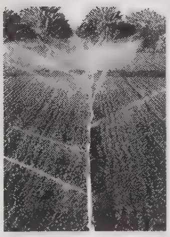

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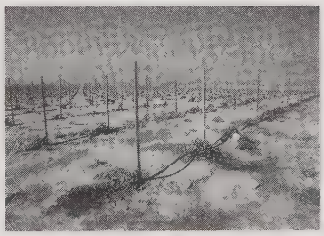

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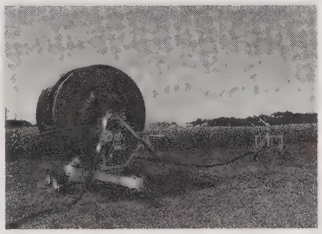

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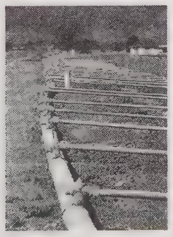

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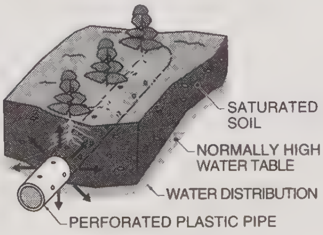
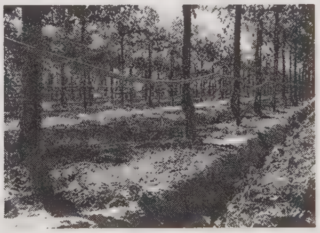

SATURATED SOIL
NORMALLY HIGH WATER TABLE
WATER DISTRIBUTION
PERFORATED PLASTIC PIPE

J



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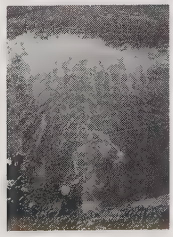

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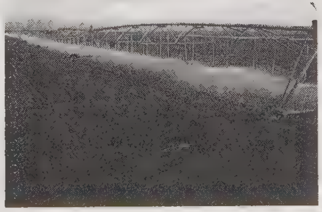

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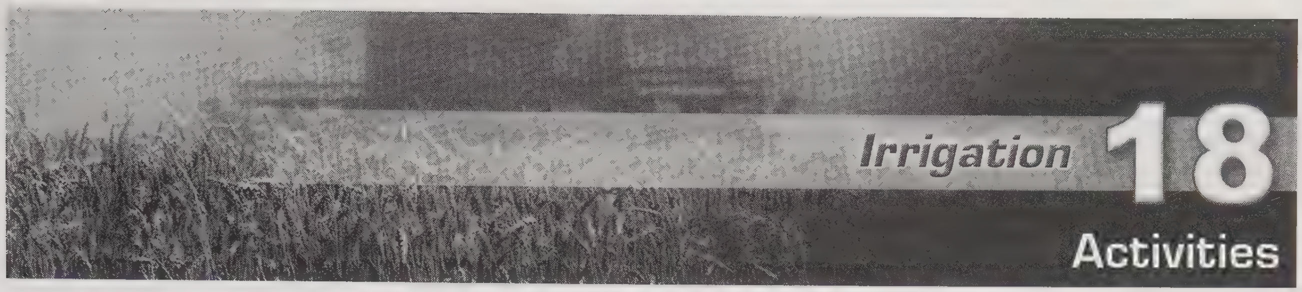


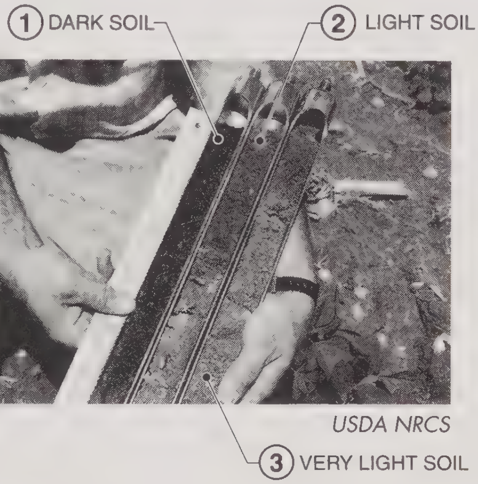
Irrigation 18

Activities

Name ______________________________ **Date** ________________

Activity 18-1: Soil Quality

Describe the soil quality and capability of supporting plant growth for each dirt sample shown.



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Activity 18-2: Rainwater Collection

Calculate rainwater collection from the following catchment areas.

________________ **1.** How much rainwater can be collected from a catchment area of 2200 sq ft with a one-time measured rainfall of 0.95″?

________________ **2.** How much rainwater can be collected from a catchment area of 3625 sq ft with a one-time measured rainfall of 0.32″?

Calculate the amount of rainfall that can be collected in a month when the size of the catchment area and the average amount of rainfall are known.

____________________ **3.** How much rainwater can be collected from a catchment area of 1250 sq ft with a monthly average measured rainfall of 2.10″?

____________________ **4.** How much rainwater can be collected from a catchment area of 35,000 sq ft with a monthly average measured rainfall of 0.62″?

Activity 18-3: Calculating Irrigation System Capacity

The theoretical capacity requirement of an irrigation system for a specific acreage can be calculated by applying the following formula:

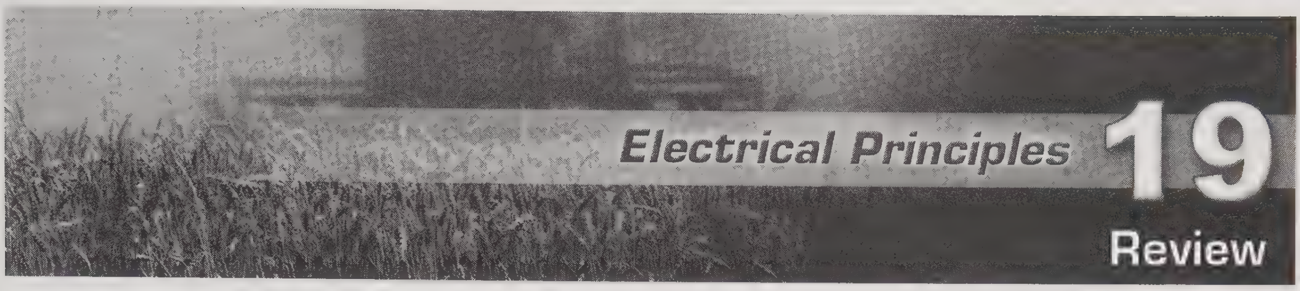
$$C = \frac{18.86 \times A \times ET_c}{t \times \frac{E_a}{100}}$$

where

C = minimum capacity requirement (in gpm)
18.86 = constant
A = area to be irrigated (in acres)
ET_c = peak evapotranspiration (in in./day)
t = time period
E_a = application efficiency (in %)

____________________ **1.** Determine the gallons per minute (gpm) required to irrigate 120 acres of grass (peak evapotranspiration of 0.21 inches per day) with a system that operates for 18 hr per day, seven days per week, with an estimated application efficiency of 70%.

____________________ **2.** Determine the gallons per minute (gpm) required to irrigate 55 acres of grass (peak evapotranspiration of 0.16 inches per day) with a system that operates for 22 hr per day, seven days per week, with an estimated application efficiency of 78%.



Electrical Principles 19

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** Static electricity is electricity at rest.

T F **2.** Matter is anything that has mass and occupies space.

T F **3.** A neutron is the smallest particle that an element can be reduced to while still maintaining the properties of that element.

T F **4.** A negative charge is an electrical charge produced when there are fewer electrons than normal.

T F **5.** Valence shells are filled starting with the inner shells and working outward, so that when the inner shell is filled with as many electrons as it can hold, the next shell is started.

T F **6.** Materials that do not allow electrons to easily move from atom to atom are conductors.

T F **7.** Conductors have more than four valence electrons.

T F **8.** Atoms are the basic materials that make up all matter.

T F **9.** Some matter may be made up of only one element, but most matter is made up of more than one element.

T F **10.** Most contacts include copper because copper has the highest electrical conductive property of all materials.

T F **11.** Energy is used to produce electricity.

T F **12.** The two forms of energy are potential energy and kinetic energy.

T F **13.** Potential energy is the energy of motion.

T F **14.** Energy used to produce electricity through a generator includes fossil fuels (coal, natural gas, and oil), nuclear power, and hydroelectric power.

T F **15.** AC voltage is voltage that flows in one direction only.

T F **16.** An alternation is a symmetrical waveform that contains 360 electrical degrees.

T F **17.** A cycle is one complete positive and negative alternation of a waveform.

T F **18.** AC voltage is either single-phase (1ϕ) or three-phase (3ϕ).

T F **19.** An ampere (A) is a unit of measure that represents the number of electrons passing a given point in 1 sec.

T F **20.** The amount of power produced in an electrical system is calculated by multiplying voltage and current.

T F **21.** With the power formula, if any two of power, voltage, or current are known, the third value can be calculated.

T F **22.** The power formula is the relationship between voltage (E), current (I), and resistance (R) in an electrical circuit.

T F **23.** Voltage indicators are used to test receptacles and fuses/circuit breakers to detect breaks in cables and for other applications in which the presence of voltage must be detected.

T F **24.** Ammeters can measure current with noncontact jaws.

T F **25.** A digital multimeter (DMM) is an electrical testing instrument that measures two or more electrical properties and displays the measured properties as numerical values.

Multiple Choice

__________ **1.** ___ electricity is electricity created by the flow of electrons through an electrical circuit.
A. Potential
B. Kinetic
C. Dynamic
D. Static

__________ **2.** A ___ is a state of matter that has a definite volume and shape.
A. solid
B. liquid
C. gas
D. none of the above

__________ **3.** Rubber, glass, plastic materials, ceramic, air, and ___ are considered insulators.
A. paper
B. aluminum
C. zinc
D. copper

______________ **4.** A(n) ___ is a particle with a positive electrical charge of 1 unit that exists in the nucleus of an atom.
A. neutron
B. proton
C. electron
D. valence shell

______________ **5.** The innermost valence shell of an atom can hold ___ electron(s).
A. one
B. two
C. three
D. four

______________ **6.** Due to the high cost of silver and gold, most conductors used in agricultural applications are made from ___.
A. scandium
B. argon
C. copper or copper-clad aluminum
D. mercury-vapor

______________ **7.** There are 118 elements, ___ of which are natural.
A. 26
B. 47
C. 71
D. 92

______________ **8.** An example of potential energy is (a) ___.
A. falling water
B. compressed spring
C. swinging hammer
D. moving vehicle

______________ **9.** ___ contacts are used in high-voltage applications because they have a high melting temperature and are less affected by arcing.
A. Tungsten
B. Gold
C. Silver
D. Copper-clad

______________ **10.** ___ is the amount of electrical pressure in a circuit.
A. Current (*I*)
B. Voltage (*E*)
C. Power (*P*)
D. Resistance (*R*)

______________ **11.** A ___ is a device that converts AC voltage to DC voltage by allowing the voltage and current to move in only one direction.
- A. transformer
- B. conductor
- C. rectifier
- D. voltmeter

______________ **12.** ___ is the number of electrons flowing through an electrical circuit.
- A. Current (I)
- B. Voltage (E)
- C. Power (P)
- D. Resistance (R)

______________ **13.** A(n) ___ is a unit of measure that represents electrical resistance.
- A. Watt (W)
- B. ampere (A)
- C. ohm (Ω)
- D. volt (V)

______________ **14.** A(n) ___ is a test instrument that indicates the presence of voltage when the test tip touches, or is near, an energized conductor or metal part.
- A. analog multimeter
- B. voltage indicator
- C. digital multimeter
- D. ammeter

______________ **15.** A(n) ___ is a meter that can measure two or more electrical properties and displays the measured properties along calibrated scales using a needle.
- A. analog multimeter
- B. voltage indicator
- C. digital multimeter
- D. ammeter

Completion

______________ **1.** ___ is a physical occurrence involving electric charges and their effects when in motion and at rest.

______________ **2.** A(n) ___ is a state of matter that has a definite volume but not a definite shape.

______________ **3.** A(n) ___ is material that has very little resistance and permits electrons to move through it easily.

______________ **4.** A(n) ___ is a negatively charged particle in an atom.

______________ **5.** A(n) ___ is an electrical charge produced when there are more electrons than normal.

______________ **6.** A(n) ___ is the outermost shell of an atom and contains the electrons that form new compounds.

______________ **7.** A(n) ___ is an electronic device that has electrical conductivity between that of a conductor (high conductivity) and that of an insulator (low conductivity).

______________ **8.** A(n) ___ is a substance that cannot be chemically broken down and contains atoms of only one variety.

______________ **9.** ___ is the formation of film on a contact surface.

______________ **10.** ___ energy is stored energy a body has due to its position, chemical state, or condition.

______________ **11.** ___ voltage is voltage that reverses its direction of flow at regular intervals.

______________ **12.** A(n) ___ is half of a cycle.

______________ **13.** A(n) ___ is a material that has a very high resistance and resists the flow of electrons.

______________ **14.** ___ is the opposition to current flow.

______________ **15.** ___ is the rate of doing work or using energy.

______________ **16.** The ___ is the relationship between power (*P*), voltage (*E*), and current (*I*) in an electrical circuit.

______________ **17.** A(n) ___ is a test instrument that measures voltage.

______________ **18.** A(n) ___ is a test instrument that measures the amount of current in an electrical circuit.

______________ **19.** A(n) ___ is a test instrument used to measure two or more electrical quantities.

______________ **20.** ___ is an analog multimeter measurement error caused by an improper viewing angle of the pointer slightly above a scale.

Short Answer

1. What is a neutron?

2. What is energy?

3. List five methods in which voltage may be produced.

4. What does the power formula state?

5. List seven quantities that can be measured with DMMs.

Identification

Test Instruments

Identify the test instruments.

________________ **1.** Ammeter

________________ **2.** Analog multimeter

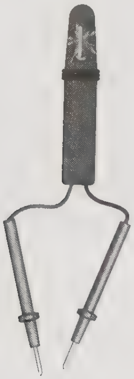
________________ **3.** Digital multimeter (DMM)

________________ **4.** Test light

________________ **5.** Voltage indicator

________________ **6.** Voltage tester

________________ **7.** Voltmeter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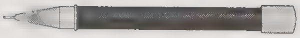
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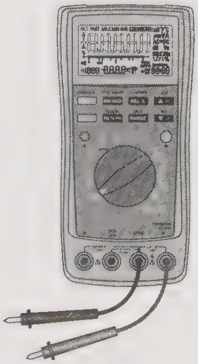
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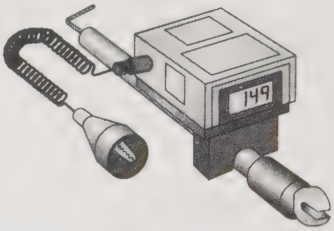

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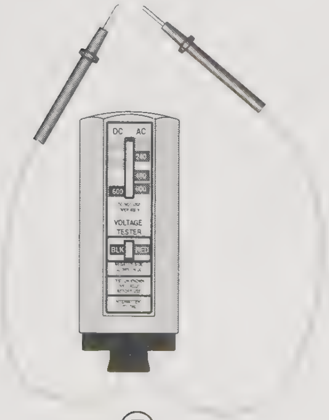
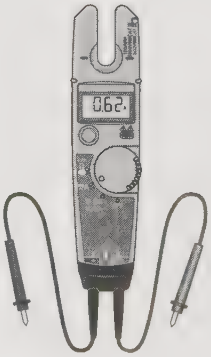

DC
AC
240
480
600
VOLTAGE TESTER
BLK
RED
Ⓔ



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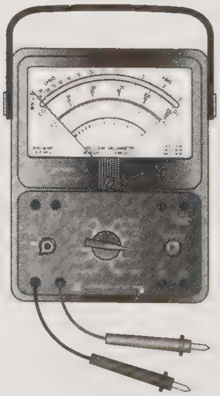
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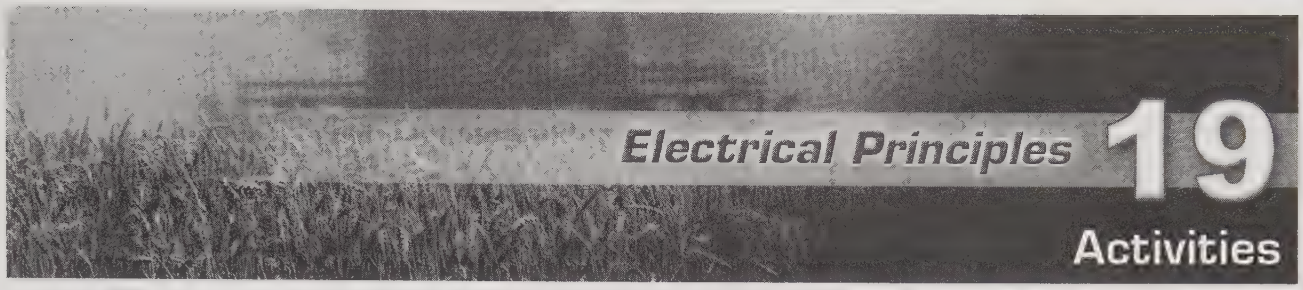


Electrical Principles 19

Activities

Name ______________________________ Date ____________________

Activity 19-1: Ohm's Law and Power Formula Calculations

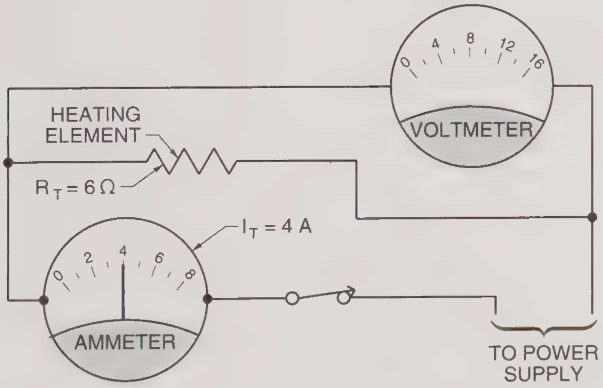
1. What is the current in a 208 V electric motor circuit that has a measured resistance of 40 Ω?

2. What is the resistance in a 4200 V electric fence circuit with current of 3 A?

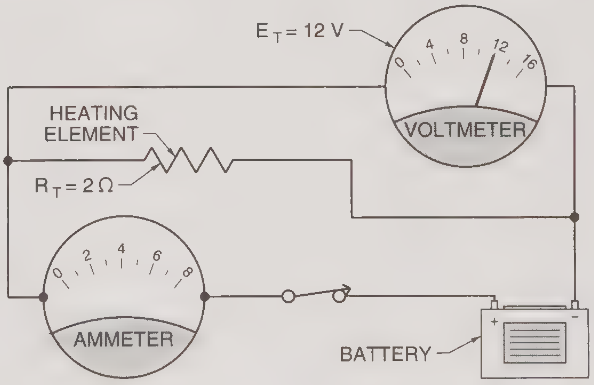
3. How much power is required for the electric fence circuit in Question #2?

4. What is the resistance in a 1200 V electric fence circuit with current of 2 A?

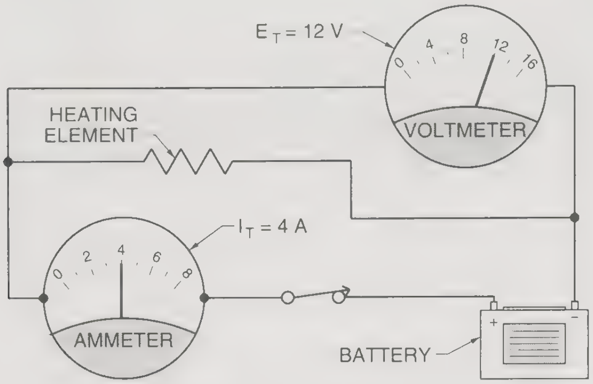
____________ **5.** E_T = ___ V


0
4
8
12
16
VOLTMETER
HEATING ELEMENT
$R_T = 6\,\Omega$
$I_T = 4$ A
0
2
4
6
8
AMMETER
TO POWER SUPPLY

____________ **6.** I_T = ___ A

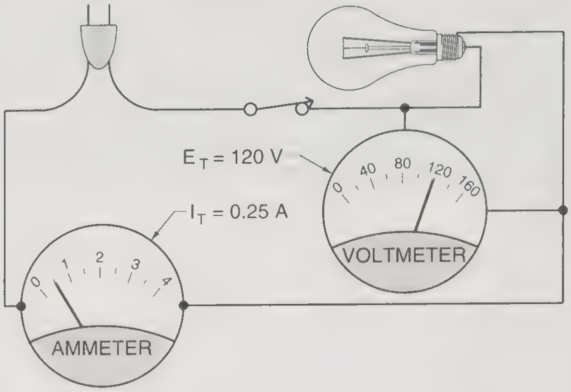

$E_T = 12$ V
0
4
8
12
16
VOLTMETER
HEATING ELEMENT
$R_T = 2\,\Omega$
0
2
4
6
8
AMMETER
+
−
BATTERY

______________ **7.** R_T = ___ Ω



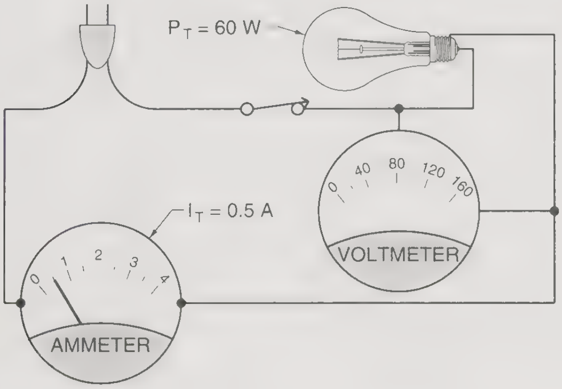
E_T = 12 V
0 4 8 12 16
VOLTMETER
HEATING ELEMENT
I_T = 4 A
0 2 4 6 8
AMMETER
BATTERY
+
−

______________ **8.** P_T = ___ W



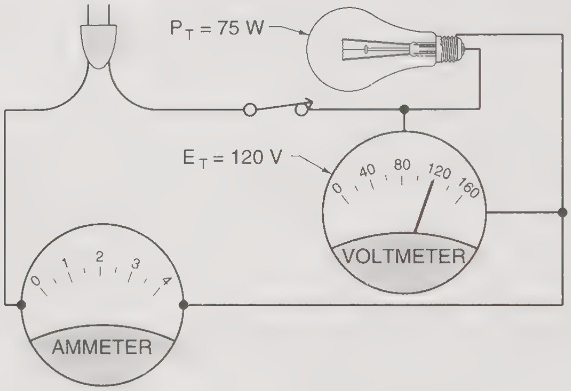
E_T = 120 V
0 40 80 120 160
VOLTMETER
I_T = 0.25 A
0 1 2 3 4
AMMETER

______________ **9.** E_T = ___ V



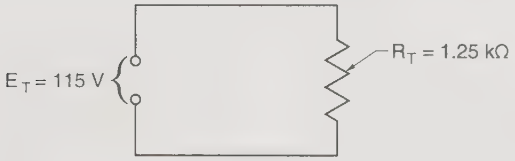
P_T = 60 W
0 40 80 120 160
VOLTMETER
I_T = 0.5 A
0 1 2 3 4
AMMETER

______________ **10.** I_T = ___ A



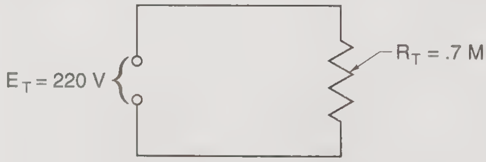
P_T = 75 W
E_T = 120 V
0 40 80 120 160
VOLTMETER
0 1 2 3 4
AMMETER

______________ **11.** I_T = ___ mA



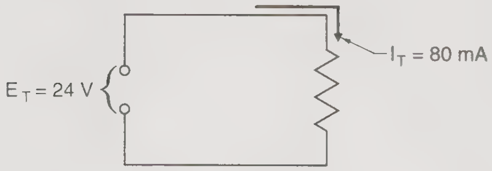
E_T = 115 V
R_T = 1.25 kΩ

______________ **12.** I_T = ___ μA



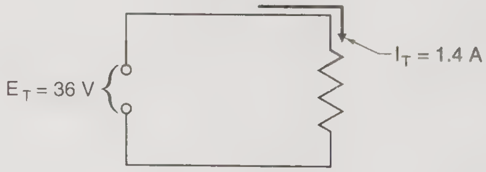
E_T = 220 V
R_T = .7 MΩ

______________ **13.** R_T = ___ Ω



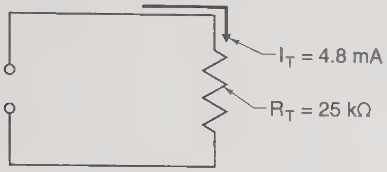
E_T = 24 V
I_T = 80 mA

______________ **14.** R_T = ___ Ω

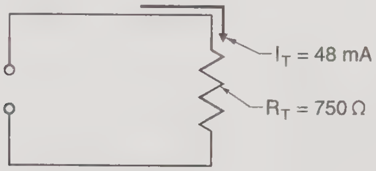


E_T = 36 V
I_T = 1.4 A

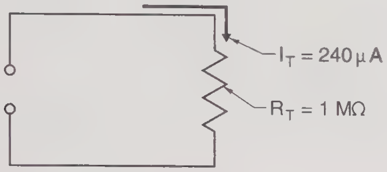
______________ **15.** E_T = ___ V


I_T = 4.8 mA
R_T = 25 kΩ

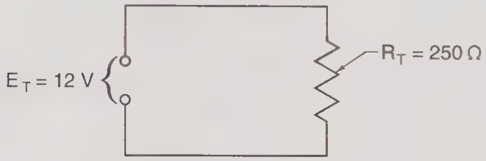
______________ **16.** E_T = ___ V


I_T = 48 mA
R_T = 750 Ω

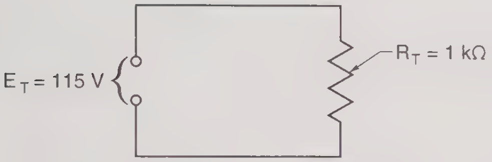
______________ **17.** E_T = ___ V


I_T = 240 μA
R_T = 1 MΩ

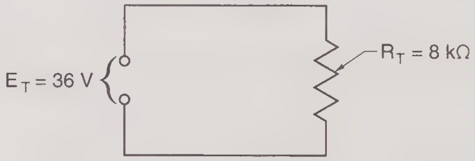
______________ **18.** P_T = ___ mW


E_T = 12 V
R_T = 250 Ω

______________ **19.** P_T = ___ W


E_T = 115 V
R_T = 1 kΩ

______________ **20.** P_T = ___ mW


E_T = 36 V
R_T = 8 kΩ

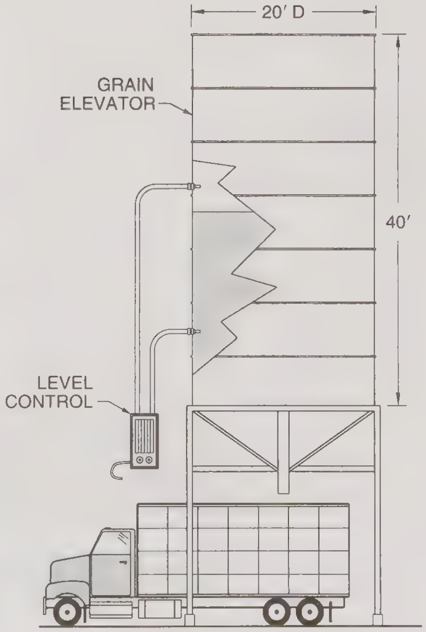
Activity 19-2: Math Conversions

______________ **1.** The floor area of the grain elevator is ___ sq ft.

______________ **2.** The circumference of the grain elevator is ___′.

______________ **3.** The grain elevator holds ___ cu yd of grain.

______________ **4.** An electric grain dryer that can process (dry) 3000 cu ft per hour must run ___ hr to process one full elevator of grain. (Round to nearest full hour.)


20′ D
GRAIN ELEVATOR
40′
LEVEL CONTROL

Activity 19-3: DMM Functions

Obtain a DMM or locate one on a manufacturers website. Check all the functions that the DMM has available.

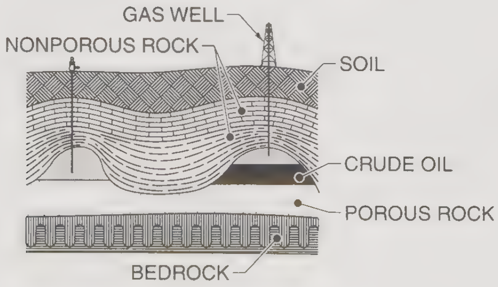
YES	NO	
☐	☐	**1.** AC voltage measurement
☐	☐	**2.** DC voltage measurement
☐	☐	**3.** DC millivolt measurement
☐	☐	**4.** Resistance measurement
☐	☐	**5.** AC milliamp measurement
☐	☐	**6.** DC milliamp measurement
☐	☐	**7.** AC amp measurement
☐	☐	**8.** DC amp measurement
☐	☐	**9.** AC microamp measurement
☐	☐	**10.** DC microamp measurement
☐	☐	**11.** Diode check function
☐	☐	**12.** Temperature measurement function
☐	☐	**13.** Capacitance measurement function
		14. List other functions available.

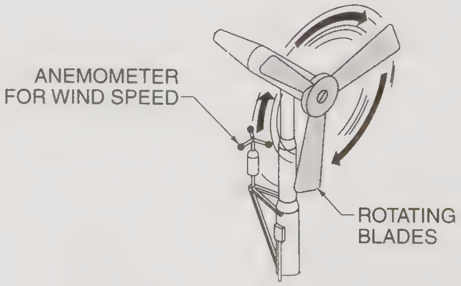
Activity 19-4: Energy

Determine if each energy source is potential or kinetic.

____________________ **1.** Crude oil is ___ energy.

____________________ **2.** Rotating blades are ___ energy.


GAS WELL
NONPOROUS ROCK
SOIL
CRUDE OIL
POROUS ROCK
BEDROCK

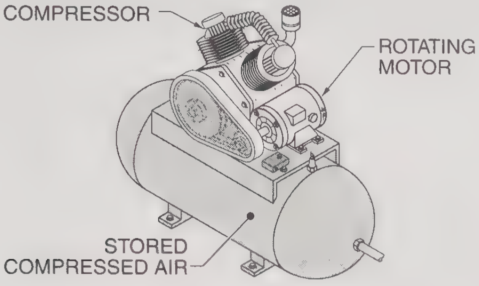

ANEMOMETER FOR WIND SPEED
ROTATING BLADES

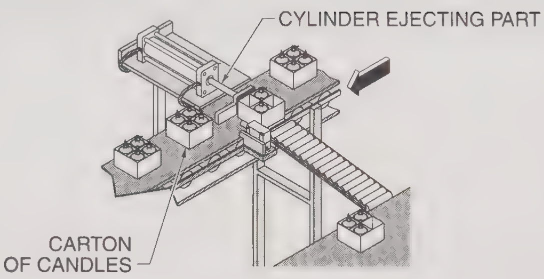
__________ **3.** A rotating motor is ___ energy.

__________ **4.** Stored compressed air is ___ energy.

__________ **5.** A cylinder ejecting a part is ___ energy.

__________ **6.** A carton of candles is ___ energy.


COMPRESSOR
ROTATING MOTOR
STORED COMPRESSED AIR


CYLINDER EJECTING PART
CARTON OF CANDLES

Activity 19-5: Chemical Elements

Using the Chemical Elements table on the following page, write the chemical symbol for each element.

__________ **1.** Oxygen = ___

__________ **2.** Carbon = ___

__________ **3.** Hydrogen = ___

__________ **4.** Nitrogen = ___

__________ **5.** Phosphorus = ___

__________ **6.** Sulfur = ___

__________ **7.** Calcium = ___

__________ **8.** Chlorine = ___

__________ **9.** Magnesium = ___

__________ **10.** Potassium = ___

__________ **11.** Aluminum = ___

__________ **12.** Copper = ___

__________ **13.** Gold = ___

__________ **14.** Iron = ___

__________ **15.** Lead = ___

__________ **16.** Mercury = ___

__________ **17.** Nickel = ___

__________ **18.** Silver = ___

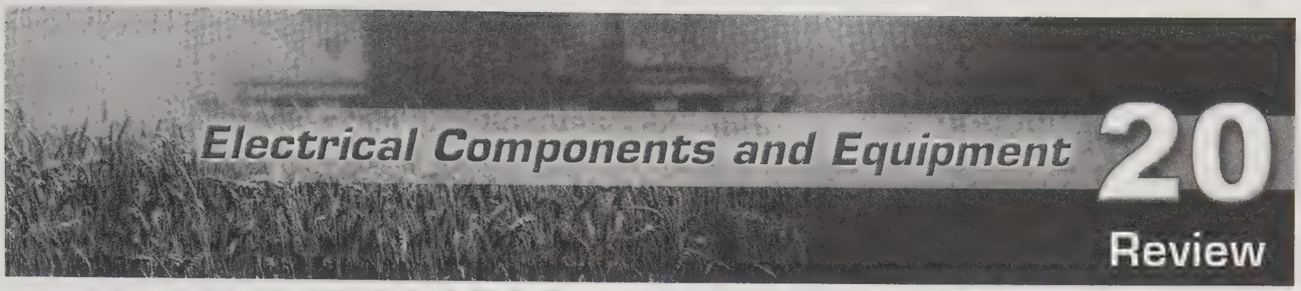
__________ **19.** Tin = ___

__________ **20.** Tungsten = ___

Chemical Elements

NAME	SYMBOL	VALENCE ELECTRONS	ATOMIC WEIGHT*	ATOMIC NUMBER
Actinium	Ac	2	[227]	89
Aluminum	Al	3	26.9815	13
Americium	Am	2	[243]	95
Antimony	Sb	5	121.75	51
Argon	Ar	8	39.948	18
Arsenic	As	5	74.9216	33
Astatine	At	7	[210]	85
Barium	Ba	2	137.34	56
Berkelium	Bk	2	[247]	97
Beryllium	Be	2	9.0122	4
Bismuth	Bi	5	208.980	83
Boron	B	3	10.811	5
Bromine	Br	7	79.909	35
Cadmium	Cd	2	112.40	48
Calcium	Ca	2	40.08	20
Californium	Cf	2	[251]	98
Carbon	C	4	12.01115	6
Cerium	Ce	2	140.12	58
Cesium	Cs	1	132.905	55
Chlorine	Cl	7	35.453	17
Chromium	Cr	1	51.996	24
Cobalt	Co	2	58.9332	27
Copper	Cu	1	63.54	29
Curium	Cm	2	[247]	96
Dysprosium	Dy	2	162.50	66
Einsteinium	Es	2	[254]	99
Erbium	Er	2	167.26	68
Europium	Eu	2	151.96	63
Fermium	Fm	2	[257]	100
Fluorine	F	7	18.9984	9
Francium	Fr	1	[223]	87
Gadolinium	Gd	2	157.25	64
Gallium	Ga	3	69.72	31
Germanium	Ge	4	72.59	32
Gold	Au	1	196.967	79
Hafnium	Hf	2	178.49	72
Helium	He	2	4.0026	2
Holmium	Ho	2	164.930	67
Hydrogen	H	1	1.00797	1
Indium	In	3	114.82	49
Iodine	I	7	126.9044	53
Iridium	Ir	2	192.2	77
Iron	Fe	2	55.847	26
Krypton	Kr	8	83.80	36
Lanthanum	La	2	138.91	57
Lawrencium	Lr	2	[256]	103
Lead	Pb	4	207.19	82
Lithium	Li	1	6.939	3
Lutetium	Lu	2	174.97	71
Magnesium	Mg	2	24.312	12
Manganese	Mn	2	54.9380	25
Mendelevium	Md	2	[258]	101
Mercury	Hg	2	200.59	80
Molybdenum	Mo	1	95.94	42
Neodymium	Nd	2	144.24	60
Neon	Ne	8	20.183	10
Neptunium	Np	2	[237]	93
Nickel	Ni	2	58.71	28
Niobium	Nb	1	92.906	41
Nitrogen	N	5	14.0067	7
Nobelium	No	2	[255]	102
Osmium	Os	2	190.2	76
Oxygen	O	6	15.9994	8
Palladium	Pd	—	106.4	46
Phosphorus	P	5	30.9738	15
Platinum	Pt	1	195.09	78
Plutonium	Pu	2	[244]	94
Polonium	Po	6	[210]	84
Potassium	K	1	39.102	19
Praseodymium	Pr	2	140.907	59
Promethium	Pm	2	[145]	61
Protactinium	Pa	2	[231]	91
Radium	Ra	2	[226]	88
Radon	Rn	8	[222]	86
Rhenium	Re	2	186.2	75
Rhodium	Rh	1	102.905	45
Rubidium	Rb	1	85.47	37
Ruthenium	Ru	1	101.07	44
Samarium	Sm	2	150.35	62
Scandium	Sc	2	44.956	21
Selenium	Se	6	78.96	34
Silicon	Si	4	28.086	14
Silver	Ag	1	107.870	47
Sodium	Na	1	22.9898	11
Strontium	Sr	2	87.62	38
Sulfur	S	6	32.064	16
Tantalum	Ta	2	180.948	73
Technetium	Tc	2	[97]	43
Tellurium	Te	6	127.60	52
Terbium	Tb	2	158.924	65
Thallium	Tl	3	204.37	81
Thorium	Th	2	232.038	90
Thulium	Tm	2	168.934	69
Tin	Sn	4	118.69	50
Titanium	Ti	2	47.90	22
Tungsten	W	2	183.85	74
Unnilennium	Une	2	[266]	109
Unnilhexium	Unh	2	[263]	106
Unniloctium	Uno	—	[265]	108
Unnilpentium	Unp	2	[262]	105
Unnilquadium	Unq	2	[261]	104
Unnilseptium	Uns	2	[262]	107
Uranium	U	2	238.03	92
Vanadium	V	2	50.942	23
Xenon	Xe	8	131.30	54
Ytterbium	Yb	2	173.04	70
Yttrium	Y	2	88.905	39
Zinc	Zn	2	65.37	30
Zirconium	Zr	2	91.22	40

* a number in brackets indicates the mass number of the most stable isotope



Electrical Components and Equipment

20

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** All direct current (DC) power sources have a definite positive and negative side.

T F **2.** DC electricity flows in only one direction.

T F **3.** A grounding conductor does not carry current normally, except during a fault (short circuit).

T F **4.** Conductors are selected based on the voltage output of the regular building supply system and the amount of load they are required to supply.

T F **5.** Mobile vehicle-mounted generators may seem to be the best choice for temporary power, but power requirements on most agricultural, commercial, and industrial installation projects are large enough to require the use of portable generators.

T F **6.** A portable generator is a generator that is permanently installed as part of a standby or emergency back-up power system.

T F **7.** The most common generators used for agricultural structures are wire and cable assemblies.

T F **8.** Wire gauge sizes are determined by the American Wire Gauge (AWG) system and begin with the assigned number 36 for a small wire with a 0.0050″ diameter.

T F **9.** A hertz is a unit of measure equal to 0.001″.

T F **10.** Grounding is typically established as system grounding or equipment grounding.

T F **11.** The two methods of grounding an electrical system are metal water pipe grounding and electrode grounding.

T F **12.** Batteries are connected in parallel to increase the total voltage.

T F **13.** A type S plug fuse is a snap-in electrical safety device that operates on the heating effect of an element.

T F **14.** The main types of circuit breakers are thermal and magnetic.

T F **15.** A thermal circuit breaker is an electrical safety device that operates with miniature electromagnets to connect or disconnect a circuit.

T F **16.** An equipotential plane is an area where wire mesh or other conductive elements are embedded in concrete or bonded to metal structures that can become energized.

T F **17.** A luminaire is an output component that converts electrical energy into light.

T F **18.** A fluorescent lamp is a lamp that produces light from an arc tube similar to the tungsten filament of an incandescent bulb.

T F **19.** A double-pole switch is an electrical control device with one movable and one fixed contact.

T F **20.** Switches are connected in such a manner that their blades are energized when the switch is in the open position.

T F **21.** The two main parts of single-phase motors are the stator and rotor.

T F **22.** Three-phase motors can be single- or dual-voltage.

T F **23.** A single-voltage motor is a motor that operates at more than one voltage level.

T F **24.** A field winding is an electromagnet used to produce a magnetic field in a generator or DC motor.

T F **25.** Batteries are connected in series to increase the total current.

Multiple Choice

______________ **1.** A(n) ___ is a unit of frequency equal to one cycle/sec.

A. ohm
B. mil
C. hertz
D. Henry

______________ **2.** With single-phase voltage, one complete electrical cycle occurs each ___ of a second.

A. 1/10
B. 1/20
C. 1/30
D. 1/60

______________ **3.** A(n) ___ is an electromechanical device that converts mechanical energy into electrical energy by means of electromagnetic induction.

A. relay
B. inductor
C. generator
D. capacitor

_______________ **4.** Three-phase motors are best used in applications such as ___.

A. manure digesters
B. portable power tools
C. residential sump pumps
D. automatic overhead door openers

_______________ **5.** Portable generators can typically have a power capacity up to ___ kW.

A. 5
B. 10
C. 15
D. 25

_______________ **6.** A(n) ___ is a movable coil of wire in a DC motor that rotates through the magnetic field.

A. commutator
B. armature
C. stator
D. field winding

_______________ **7.** An explosionproof lamp would be best installed in a(n) ___.

A. equipment repair shop
B. mobile equipment storage structure
C. grain storage silo
D. dairy silo

_______________ **8.** A ___ is a snap-in electrical safety device.

A. type S plug fuse
B. cartridge fuse
C. standard plug fuse
D. circuit breaker

_______________ **9.** A ___ switch controls a fixture from two different locations and must always be used in pairs.

A. single-pole
B. double-pole
C. three-way
D. four-way

_______________ **10.** Fluorescent lamps are sized in ___.

A. millimeters
B. inches
C. light output (lumens)
D. wattage

_______________ **11.** A(n) ___ lamp is an electric lamp that produces light by the flow of current through a tungsten filament inside a sealed glass bulb normally filled with a gas.

A. incandescent
B. high-intensity discharge (HID)
C. fluorescent
D. light-emitting diode (LED)

______ 12. The most common switch used in agricultural installations is a ___ switch.
- A. single-pole
- B. double-throw
- C. single-pole, single-throw
- D. three-way

______ 13. A ___ switch is a switch that can change circuit connections by moving the switchblade into one of two operating positions.
- A. single-pole, single-throw
- B. single-pole
- C. double-pole
- D. double-throw

______ 14. A ___ is the stationary part of an AC motor that produces a rotating magnetic field.
- A. stator
- B. rotor
- C. motor
- D. winding

______ 15. A(n) ___ changes voltage level by stepping up or stepping down the voltage.
- A. relay
- B. transformer
- C. alternator
- D. generator

Completion

______ 1. A(n) ___ is a DC voltage source that converts chemical energy to electrical energy.

______ 2. ___ power is power from a voltage source that contains three alternating voltage waveforms.

______ 3. A(n) ___ generator is a generator that can easily be moved from one location to another without the use of special equipment.

______ 4. A(n) ___ is a flexible wire assembly containing multiple conductors with a protective outer sheath.

______ 5. ___ is the connection of all exposed non-current-carrying metal parts to the earth.

______ 6. A(n) ___ is a permanent conductor placed across a water meter to provide a continuous flow path for ground current.

______ 7. A(n) ___ ground is a circuit designed to protect individual components connected to an electrical system.

______ 8. A(n) ___ is an electrical overcurrent protection device with a fusible portion that is heated and broken by the passage of excessive current.

______ 9. A(n) ___ fuse is a screw-in type electrical safety device with all the operating characteristics of a time-delay plug fuse, plus the advantage of being tamperproof.

______ 10. A(n) ___ circuit breaker is an electrical safety device with a bimetallic strip that warps when overheated.

__________________ **11.** A(n) ___ is a type of receptacle designed to help protect occupants by detecting ground faults and quickly disconnecting the power from a circuit that has developed a ground fault.

__________________ **12.** A(n) ___ lamp is a low-pressure discharge lamp in which ionization of mercury vapor transforms ultraviolet energy generated by the discharge into light.

__________________ **13.** A(n) ___ is a diode that emits light when forward direct current is applied.

__________________ **14.** A(n) ___ switch is an electrical switch used in conjunction with two three-way switches to provide control of a circuit from three or more locations.

__________________ **15.** A(n) ___ is a rotating output component that converts electrical power into a rotating, mechanical force.

__________________ **16.** A(n) ___ motor is a motor that operates on three-phase electricity.

__________________ **17.** A(n) ___ motor is a motor that operates at only one voltage level.

__________________ **18.** A(n) ___ motor is a motor that uses direct current connected to the field and armature to produce shaft rotation.

__________________ **19.** A(n) ___ is a ring made of segments that are insulated from one another.

__________________ **20.** A(n) ___ is the sliding contact that rides against the commutator segments and is used to connect the armature to the external circuit.

Short Answer

1. Briefly explain the difference between the three conductors required for single-phase power and the three conductors required for three-phase power.

2. In electrical systems, what is an electrode?

3. List the advantages and disadvantages of incandescent lamps.

4. What is a diode?

5. What is the difference between a single-phase motor and a three-phase motor?

Identification

Electrical Symbols

Identify the electrical symbols.

______________ **1.** Armature

______________ **2.** Ceiling light

______________ **3.** Circuit breaker

______________ **4.** Continuous wireway for fluorescent lighting

______________ **5.** Double-pole, single-throw disconnect switch

______________ **6.** Double-pole, single-throw switch

______________ **7.** Exit lighting

______________ **8.** Four-way switch

______________ **9.** Fuse

______________ **10.** GFCI

______________ **11.** GFCI with ON/OFF switch

______________ **12.** Lighting outlet with lamp holder and pull switch

______________ **13.** Lighting outlet with lamp holder

______________ **14.** Multiple assembly flood lighting

______________ **15.** Recessed ceiling fixture

______________ **16.** Single-phase motor

______________ **17.** Single-pole, single-throw disconnect switch

______________ **18.** Three-phase motor

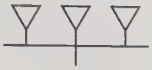
______________ **19.** Three-pole, single-throw disconnect switch

______________ **20.** Three-way (single-pole), double-throw switch

______________ **21.** Track lighting

______________ **22.** Two-way (single-pole), single-throw switch

______________ **23.** Wall light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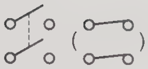
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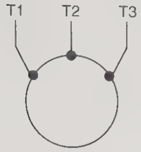

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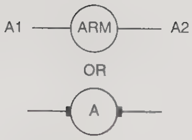
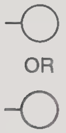

A1
ARM
A2
OR
A
Ⓓ



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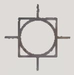
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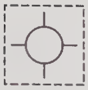
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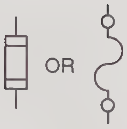

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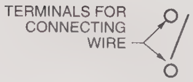
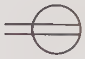

TERMINALS FOR CONNECTING WIRE
Ⓙ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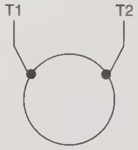

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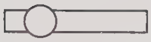
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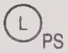

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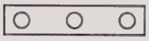
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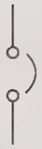
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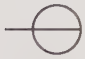
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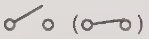
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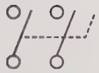
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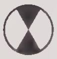
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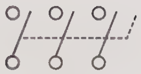
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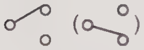
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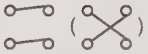
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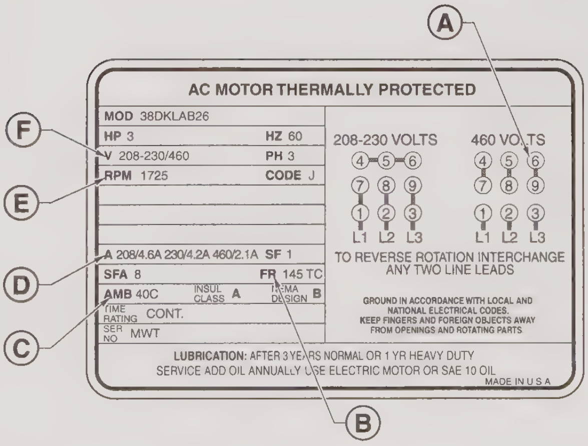
Electric Motor Nameplates

Identify the electric motor nameplate information.


Ⓐ
AC MOTOR THERMALLY PROTECTED
MOD 38DKLAB26
Ⓕ
HP 3
HZ 60
V 208-230/460
PH 3
Ⓔ
RPM 1725
CODE J
A 208/4.6A 230/4.2A 460/2.1A
SF 1
Ⓓ
SFA 8
FR 145 TC
AMB 40C
INSUL CLASS A
NEMA DESIGN B
Ⓒ
TIME RATING CONT.
SER NO MWT
208-230 VOLTS
4 5 6
7 8 9
1 2 3
L1 L2 L3
460 VOLTS
4 5 6
7 8 9
1 2 3
L1 L2 L3
TO REVERSE ROTATION INTERCHANGE ANY TWO LINE LEADS
GROUND IN ACCORDANCE WITH LOCAL AND NATIONAL ELECTRICAL CODES. KEEP FINGERS AND FOREIGN OBJECTS AWAY FROM OPENINGS AND ROTATING PARTS
LUBRICATION: AFTER 3 YEARS NORMAL OR 1 YR HEAVY DUTY SERVICE ADD OIL ANNUALLY USE ELECTRIC MOTOR OR SAE 10 OIL
MADE IN U S A
Ⓑ

________________ **1.** Full-load ampere rating

________________ **2.** Full-load speed

________________ **3.** Motor dimensions

________________ **4.** Standard ambient temperature

________________ **5.** Voltage rating

________________ **6.** Wiring diagram

Lamps

Identify the lamps.

______________ **1.** Metal-halide

______________ **2.** Fluorescent

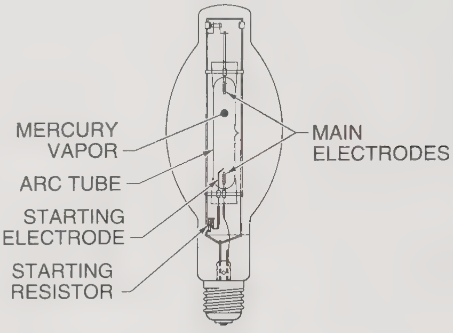
______________ **3.** Low-pressure sodium

______________ **4.** Incandescent

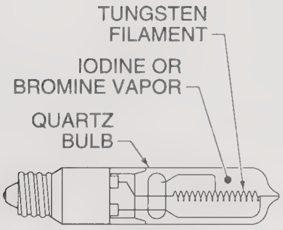
______________ **5.** Mercury-vapor

______________ **6.** Tungsten-halogen

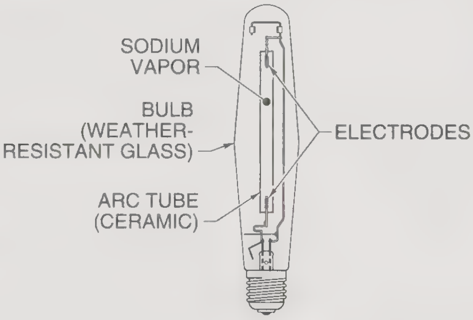
______________ **7.** High-pressure sodium


MERCURY VAPOR
ARC TUBE
STARTING ELECTRODE
STARTING RESISTOR
MAIN ELECTRODES

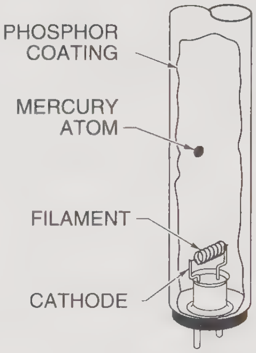
Ⓐ


TUNGSTEN FILAMENT
IODINE OR BROMINE VAPOR
QUARTZ BULB

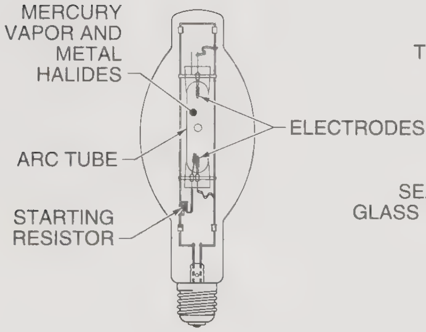
Ⓑ


SODIUM VAPOR
BULB (WEATHER-RESISTANT GLASS)
ARC TUBE (CERAMIC)
ELECTRODES

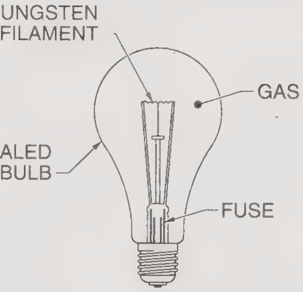
Ⓒ


PHOSPHOR COATING
MERCURY ATOM
FILAMENT
CATHODE

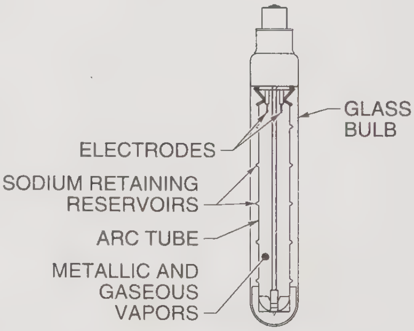
Ⓓ


MERCURY VAPOR AND METAL HALIDES
ARC TUBE
STARTING RESISTOR
ELECTRODES

Ⓔ


TUNGSTEN FILAMENT
SEALED GLASS BULB
GAS
FUSE

Ⓕ


ELECTRODES
SODIUM RETAINING RESERVOIRS
ARC TUBE
METALLIC AND GASEOUS VAPORS
GLASS BULB

Ⓖ

Electrical Components and Equipment

20

Activities

Name ______________________________ **Date** ________________

Activity 20-1: Unit Conversion

Calculate the diameters, in inches, of the different conductor sizes. Note: Round answer up to the nearest thousandth.

________________ **1.** 3 mils = ___″

________________ **2.** 4 mils = ___″

________________ **3.** 5 mils = ___″

________________ **4.** 6 mils = ___″

________________ **5.** 8 mils = ___″

________________ **6.** 10 mils = ___″

________________ **7.** 13 mils = ___″

________________ **8.** 16 mils = ___″

________________ **9.** 20 mils = ___″

________________ **10.** 25 mils = ___″

________________ **11.** 32 mils = ___″

________________ **12.** 36 mils = ___″

________________ **13.** 40 mils = ___″

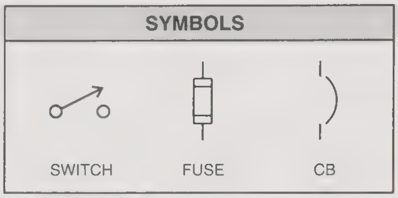
________________ **14.** 45 mils = ___″

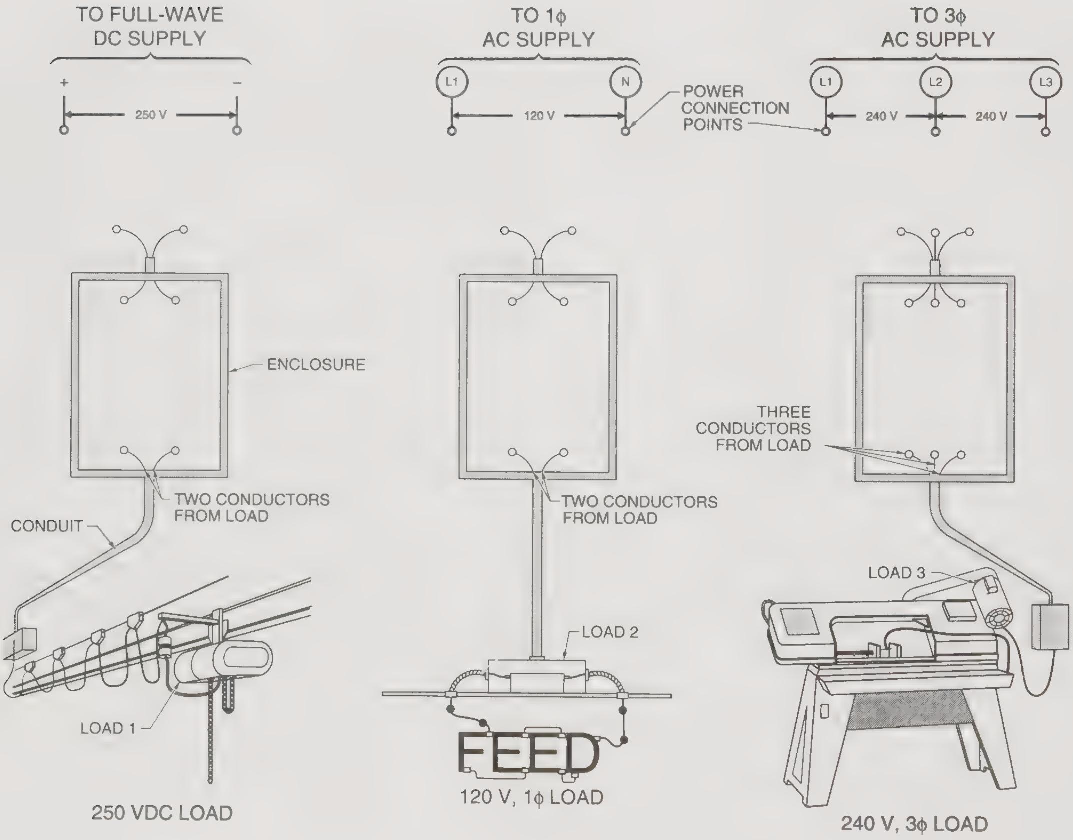
________________ **15.** 51 mils = ___″

________________ **16.** 64 mils = ___″

Activity 20-2: Fuses and Circuit Breakers

1. Every ungrounded (hot) power line must be protected against short circuits and overloads. Connect loads 1 and 2 to the proper power supply by adding the correct number of switch(es) and fuse(s) inside each enclosure and connecting these to the correct power supply. Connect load 3 to the proper power supply by adding the correct number of switch(es) and circuit breaker(s) inside the enclosure and connecting these to the correct power supply.


SYMBOLS
SWITCH
FUSE
CB


TO FULL-WAVE DC SUPPLY
+
–
250 V
TO 1ϕ AC SUPPLY
L1
N
120 V
POWER CONNECTION POINTS
TO 3ϕ AC SUPPLY
L1
L2
L3
240 V
240 V
ENCLOSURE
TWO CONDUCTORS FROM LOAD
CONDUIT
LOAD 1
250 VDC LOAD
TWO CONDUCTORS FROM LOAD
LOAD 2
FEED
120 V, 1ϕ LOAD
THREE CONDUCTORS FROM LOAD
LOAD 3
240 V, 3ϕ LOAD

Activity 20-3: Switch Circuit

The first electrical system for communication over distances was the telegraph system, which used electrical signals made up of dots, dashes, and spaces to send messages. Telegraph messages and news were transmitted using Morse code. Morse code is named after Samuel Morse, who patented the telegraph in 1840. This code is considered the simplest communication code used by military and civilian emergency personnel.

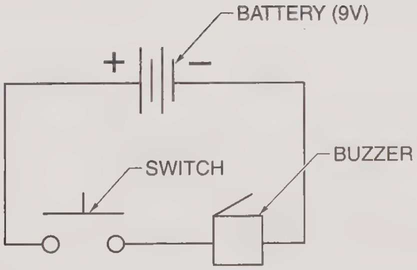
A	•—	N	—•	1	•————
B	—•••	O	———	2	••———
C	—•—•	P	•——•	3	•••——
D	—••	Q	——•—	4	••••—
E	•	R	•—•	5	•••••
F	••—•	S	•••	6	—••••
G	——•	T	—	7	——•••
H	••••	U	••—	8	———••
I	••	V	•••—	9	————•
J	•———	W	•——	0	—————
K	—•—	X	—••—		
L	•—••	Y	—•——		
M	——	Z	——••		

INTERNATIONAL MORSE CODE

Materials Needed:

- 9 V battery
- Low voltage wires
- Pushbutton or toggle switch
- Buzzer or chime

1. Build the following circuit.



2. Write down your initials in Morse code.

3. Using the circuit built in Step 1, practice sending your initials in Morse code by pressing the pushbutton for long (dash) or short (dot) periods.

4. Send a word to another student in the class and have that student decode the word.

5. Have another student send a word and decode the word from the student.

Electrical Distribution Systems and Control Circuits

21

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** The purpose of the National Electrical Code® (NEC®) is the practical safeguarding of persons and property from hazards that may arise from using electricity.

T F **2.** A conductor is a heat power source that produces electricity when two different metals that are joined together are heated.

T F **3.** Photovoltaic cells typically produce only about 0.5 V at 10 mA but can be interconnected like battery cells to deliver high voltage and current outputs.

T F **4.** All switches, including relays, contactors, and motor starters, use contacts to start or stop the flow of current in a circuit.

T F **5.** Contact position is the position of the contacts before the contacts are activated.

T F **6.** Poles denote the number of different circuits that each individual pole is capable of controlling.

T F **7.** A step-down transformer is a transformer in which the secondary-coil output voltage is greater than the primary-coil input voltage.

T F **8.** General wiring is the wiring used to connect electrical components in a circuit.

T F **9.** Aluminum conductors can carry a higher current than copper conductors for a given wire size.

T F **10.** Wiring methods for feeder circuits include conductors in raceways, service-entrance (SE) cable, or metal-clad (MC) cable.

T F **11.** The types of raceway systems used for specific structures are indicated in the print specifications and governed by electrical codes adopted for local use.

T F **12.** Electrical nonmetallic tubing (ENT) is a light-gauge electrical pipe often referred to as thin-wall conduit.

T F **13.** Electrical metallic tubing (EMT) is a flexible corrugated plastic raceway.

T F **14.** Type NMC cable is a nonmetallic-sheathed cable with the conductors enclosed within a corrosion-resistant, nonmetallic jacket used for interior or exterior wiring.

T F **15.** Large agricultural structures (dairy processing facilities, poultry barns, etc.) require voltages of over 1000 V to be delivered and distributed to different transformer banks throughout the building.

T F **16.** A motor delivers more torque and operates at a lower temperature when connected to a voltage source lower than the motor's rated voltage.

T F **17.** A silicon-controlled rectifier (SCR) circuit may be used to set and maintain the amount of heat output of a heating element.

T F **18.** Insulation that is colored black is used for the neutral (grounded circuit) conductor.

T F **19.** White is the most common color used for ungrounded conductors.

T F **20.** A wire marker is a preprinted peel-off marker designed to adhere when wrapped around a conductor.

T F **21.** A duplex receptacle is a receptacle that has two contact devices mounted on the same yoke.

T F **22.** An overcurrent protective device (OCPD) is a receptacle that interrupts the flow of current to the load when a ground fault occurs that exceeds a predetermined value of current.

T F **23.** The two main sections most control circuit diagrams can be divided into are the main power circuit and the control circuit.

T F **24.** With few exceptions, disconnects are required in all circuits that control large loads over 5 A.

T F **25.** Schematic diagrams are used as representations of the logical sequence of steps that occur in a control circuit.

Multiple Choice

______________ **1.** The NEC® is published by the ___.

A. Occupational Safety and Health Administration (OSHA)
B. Institute of Electrical and Electronic Engineers (IEEE)
C. National Fire Protection Association (NFPA)
D. Independent Electrical Contractors (IEC)

______________ **2.** A ___ is a magnetic power source that produces electricity when a rotating conductor cuts magnetic lines of force.

A. transformer
B. generator
C. thermocouple
D. condenser

______________ **3.** A ___ operates by producing an analog voltage that is typically used to provide a measurement of temperature.
   A. thermocouple
   B. relay
   C. switch
   D. converter

______________ **4.** ___ are specifically used to manually remove power from or apply power to a circuit.
   A. Contacts
   B. Disconnect switches
   C. Throws
   D. Poles

______________ **5.** A ___ is the conducting part of a switch or relay that operates with another conducting part to make or break a circuit.
   A. contact
   B. relay
   C. converter
   D. terminal

______________ **6.** A ___ is an electrical interface device that has no moving parts and is designed to change AC electricity from one voltage level to another voltage level.
   A. circuit breaker
   B. GFCI
   C. generator
   D. transformer

______________ **7.** A(n) ___ is a type of transformer that changes voltage level using the same common coil for both the primary and secondary sides.
   A. step-up transformer
   B. step-down transformer
   C. autotransformer
   D. current transformer

______________ **8.** A ___ is a location for the entry of electric utilities into a structure.
   A. raceway
   B. service entrance
   C. substation
   D. branch circuit panel

______________ **9.** Electrical metallic tubing (EMT) is approximately ___% lighter than rigid metal conduit (RMC).
   A. 15
   B. 25
   C. 40
   D. 50

______________ **10.** ___ cable is an assembly of insulated conductors with a covering consisting of a helically wound metal strip with interlocking edges.
A. Assembly
B. Service-entrance
C. Nonmetallic-sheathed
D. Armored

______________ **11.** Type ___ cable is a nonmetallic-sheathed cable with the conductors enclosed within a nonmetallic jacket used for dry interior wiring.
A. MNC
B. MN
C. NM
D. NMC

______________ **12.** Insulation that is ___ stripe is the standard color for a grounding conductor in the electrical field.
A. black or black with a red
B. white or white with a black
C. green or green with a yellow
D. red or red with a white

______________ **13.** A ___ is an electrical contact device for connecting electrical equipment to a power source.
A. diode
B. converter
C. relay
D. receptacle

______________ **14.** A ___ is a device that controls one electrical circuit by opening and closing contacts in another circuit.
A. switch
B. converter
C. relay
D. contactor

______________ **15.** A ___ is a control device that uses a small control current to energize or deenergize the load connected to it.
A. contactor
B. feeder
C. converter
D. conductor

Completion

______________ **1.** A(n) ___ is a chemical power source that produces electricity through a chemical reaction between battery plates and battery acid.

________________ **2.** A(n) ___ is a solar power source that produces electricity when light strikes the surface of the cell.

________________ **3.** A(n) ___ switch is a switch that is used to remove electrical power from motors and machines.

________________ **4.** A(n) ___ is a circuit breaker or fuse that provides overcurrent protection to a circuit.

________________ **5.** A(n) ___ is a device that detects the amount of current flowing in a motor circuit by sensing the heat generated by the current flow.

________________ **6.** ___ is the number of times the contacts of a switch or relay can be actuated before malfunctioning.

________________ **7.** A(n) ___ is an isolated circuit contact that is used to activate individual circuits.

________________ **8.** A(n) ___ is a closed contact position for a pole.

________________ **9.** A(n) ___ transformer is a transformer in which a coil is placed around a wire that carries current.

________________ **10.** A(n) ___ is a circuit conductor between the service equipment and the last branch-circuit OCPD.

________________ **11.** A(n) ___ is an enclosed channel designed to protect electrical conductors.

________________ **12.** ___, also known as polyvinyl chloride (PVC), is a waterproof, rustproof, and decay resistant nonmetallic pipe used for protection of electrical conductors.

________________ **13.** ___ is an assembly of two or more insulated conductors with an outer sheathing of moisture-resistant, flame-retardant, and nonmetallic material.

________________ **14.** ___ cable is cable that is used for service-entrance wiring or general interior wiring.

________________ **15.** A(n) ___ is an assemblage of equipment installed for switching, changing, or regulating the voltage of electricity.

________________ **16.** A(n) ___ is a current-carrying conductor that is connected to loads through fuses, circuit breakers, and switches.

________________ **17.** A(n) ___ receptacle is manufactured to supply various types of electrical loads and meets UL safety standards for general use.

________________ **18.** A(n) ___ receptacle is a receptacle that is suitable for installation in locations that are subject to explosions.

________________ **19.** A(n) ___ diagram is a drawing that shows electrical system circuitry using symbols that depict electrical devices and lines that represent conductors.

________________ **20.** A(n) ___ is a device used to open and close contacts that control current flow to a load.

Short Answer

1. What is the NEC®?

2. What is a break, as related to an electric circuit?

3. List five common types of raceway systems used in new construction.

4. What is the purpose of using different colors of insulating material on conductors?

5. Explain the difference between a schematic diagram and a ladder diagram.

Identification

Raceway Systems

Identify the types of raceway systems.

______________ **1.** AC armored cable

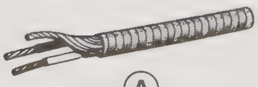
______________ **2.** Electrical metallic tubing

______________ **3.** Electrical nonmetallic tubing

______________ **4.** Nonmetallic-sheathed cable

______________ **5.** Rigid nonmetallic conduit

______________ **6.** Service-entrance cable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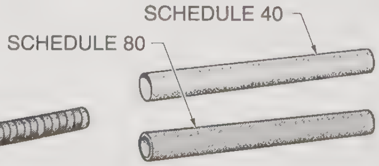

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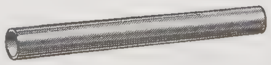
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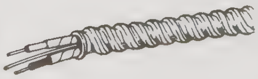
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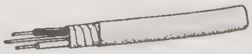
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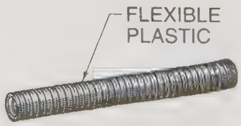

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Electrical Symbols

Identify the electrical symbols.

______________ **1.** AC generator

______________ **2.** Air-core transformer

______________ **3.** Autotransformer

______________ **4.** Battery

______________ **5.** Control-circuit transformer

______________ **6.** DC generator

______________ **7.** Ground

______________ **8.** Iron-core transformer

______________ **9.** Mechanical contact (closed)

______________ **10.** Mechanical contact (open)

______________ **11.** Photovoltaic cell

______________ **12.** Plug and receptacle

______________ **13.** Power wiring

______________ **14.** Shield

______________ **15.** Single-phase current transformer

______________ **16.** Solid-state contact (open)

______________ **17.** Thermal overload

______________ **18.** Thermocouple

______________ **19.** Three-phase current transformer

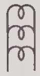
______________ **20.** Three-phase disconnect with fuses

______________ **21.** Three-phase disconnect with circuit breakers

______________ **22.** Wire bundle

______________ **23.** Wire connected

______________ **24.** Wire not connected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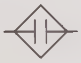
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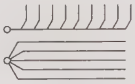
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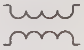
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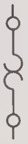
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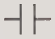
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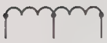
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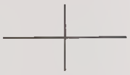
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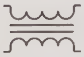
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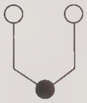
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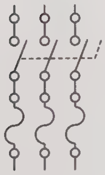
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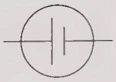
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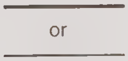

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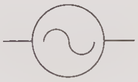
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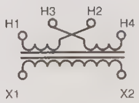

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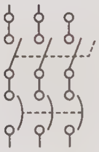
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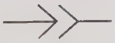
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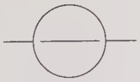
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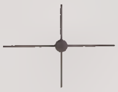
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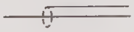
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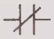
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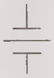
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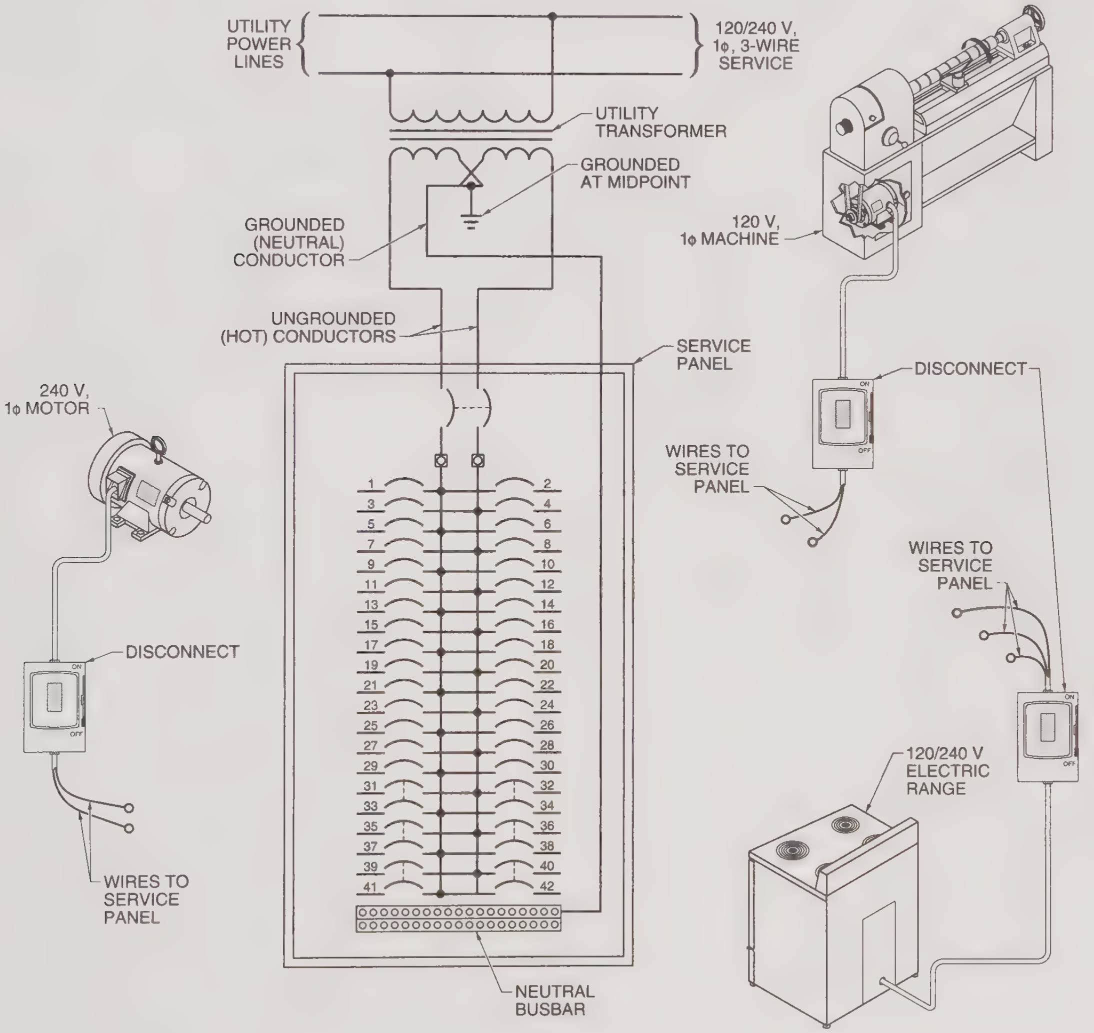
Electrical Distribution Systems and Control Circuits 21

Activities

Name ______________________________ Date ______________

Activity 21-1: 120/240 V, 1ϕ, 3-Wire Service Wiring

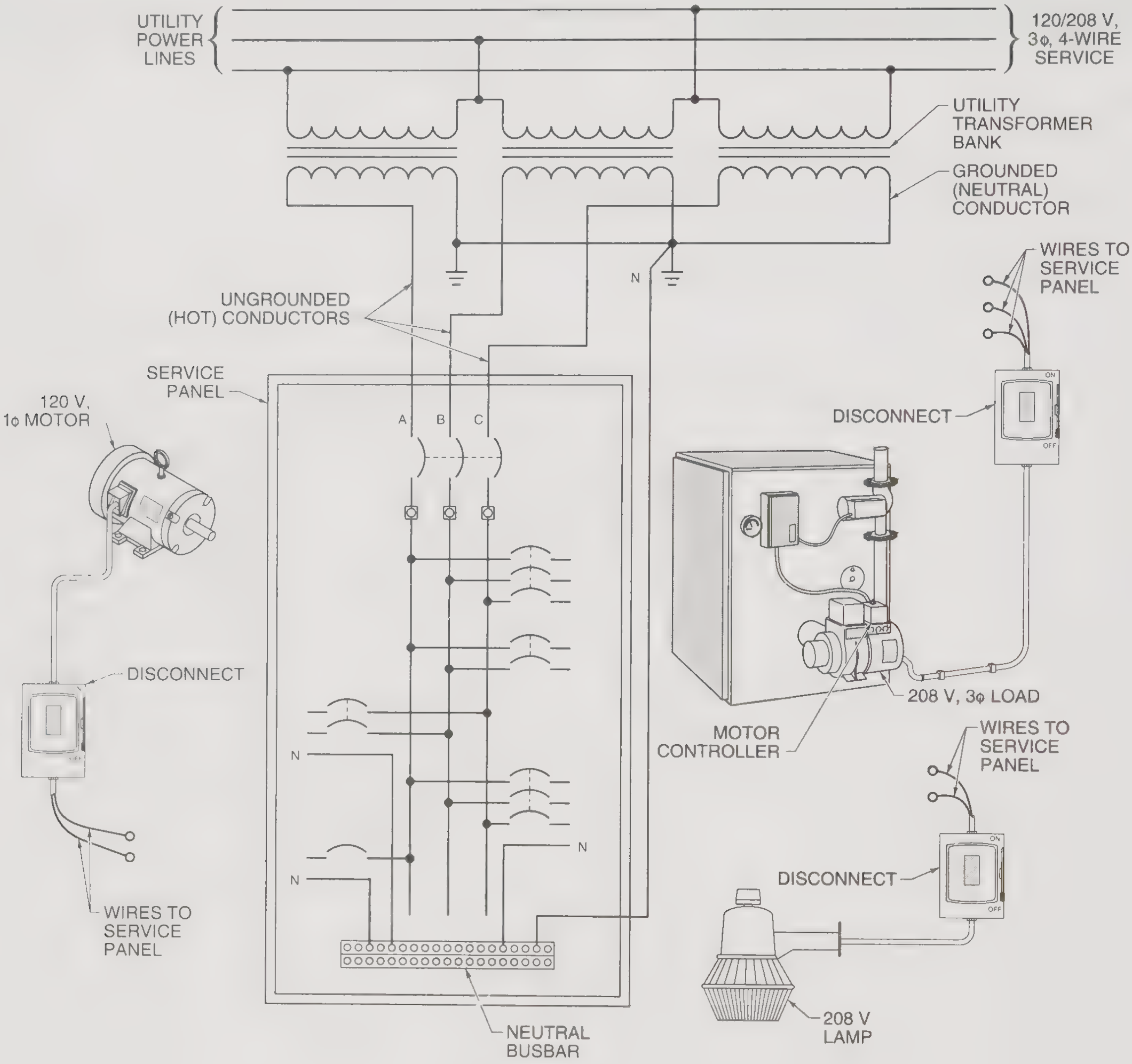
1. Connect each load to the service panel.



UTILITY POWER LINES
120/240 V, 1ϕ, 3-WIRE SERVICE
UTILITY TRANSFORMER
GROUNDED AT MIDPOINT
GROUNDED (NEUTRAL) CONDUCTOR
UNGROUNDED (HOT) CONDUCTORS
SERVICE PANEL
120 V, 1ϕ MACHINE
DISCONNECT
ON
OFF
WIRES TO SERVICE PANEL
240 V, 1ϕ MOTOR
DISCONNECT
ON
OFF
WIRES TO SERVICE PANEL
WIRES TO SERVICE PANEL
ON
OFF
120/240 V ELECTRIC RANGE
NEUTRAL BUSBAR
1 2
3 4
5 6
7 8
9 10
11 12
13 14
15 16
17 18
19 20
21 22
23 24
25 26
27 28
29 30
31 32
33 34
35 36
37 38
39 40
41 42

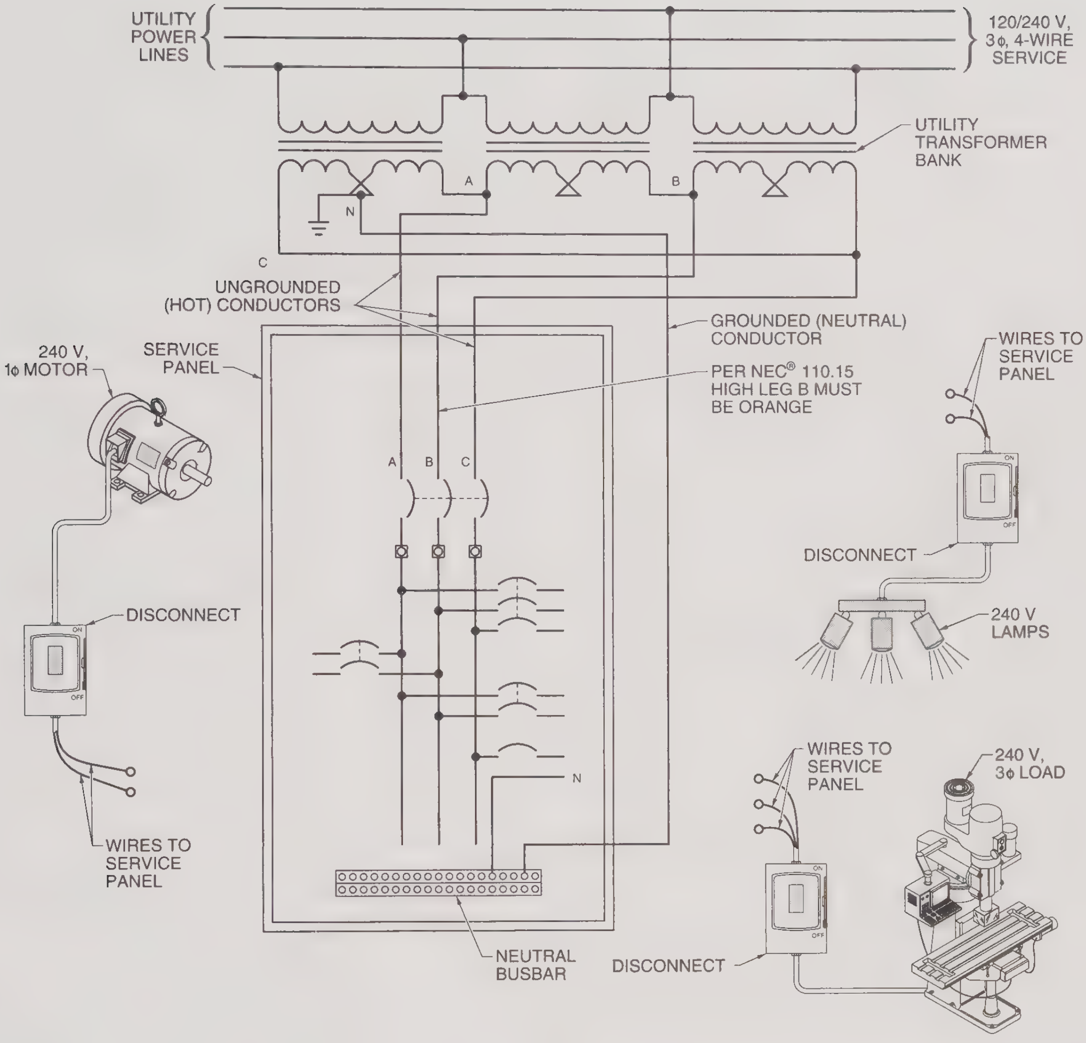
Activity 21-2: 120/208 V, 3ϕ, 4-Wire Service Wiring

1. Connect each load to the service panel.


UTILITY POWER LINES
120/208 V, 3ϕ, 4-WIRE SERVICE
UTILITY TRANSFORMER BANK
GROUNDED (NEUTRAL) CONDUCTOR
WIRES TO SERVICE PANEL
UNGROUNDED (HOT) CONDUCTORS
N
SERVICE PANEL
120 V, 1ϕ MOTOR
A
B
C
DISCONNECT
DISCONNECT
N
N
N
208 V, 3ϕ LOAD
MOTOR CONTROLLER
WIRES TO SERVICE PANEL
DISCONNECT
WIRES TO SERVICE PANEL
NEUTRAL BUSBAR
208 V LAMP

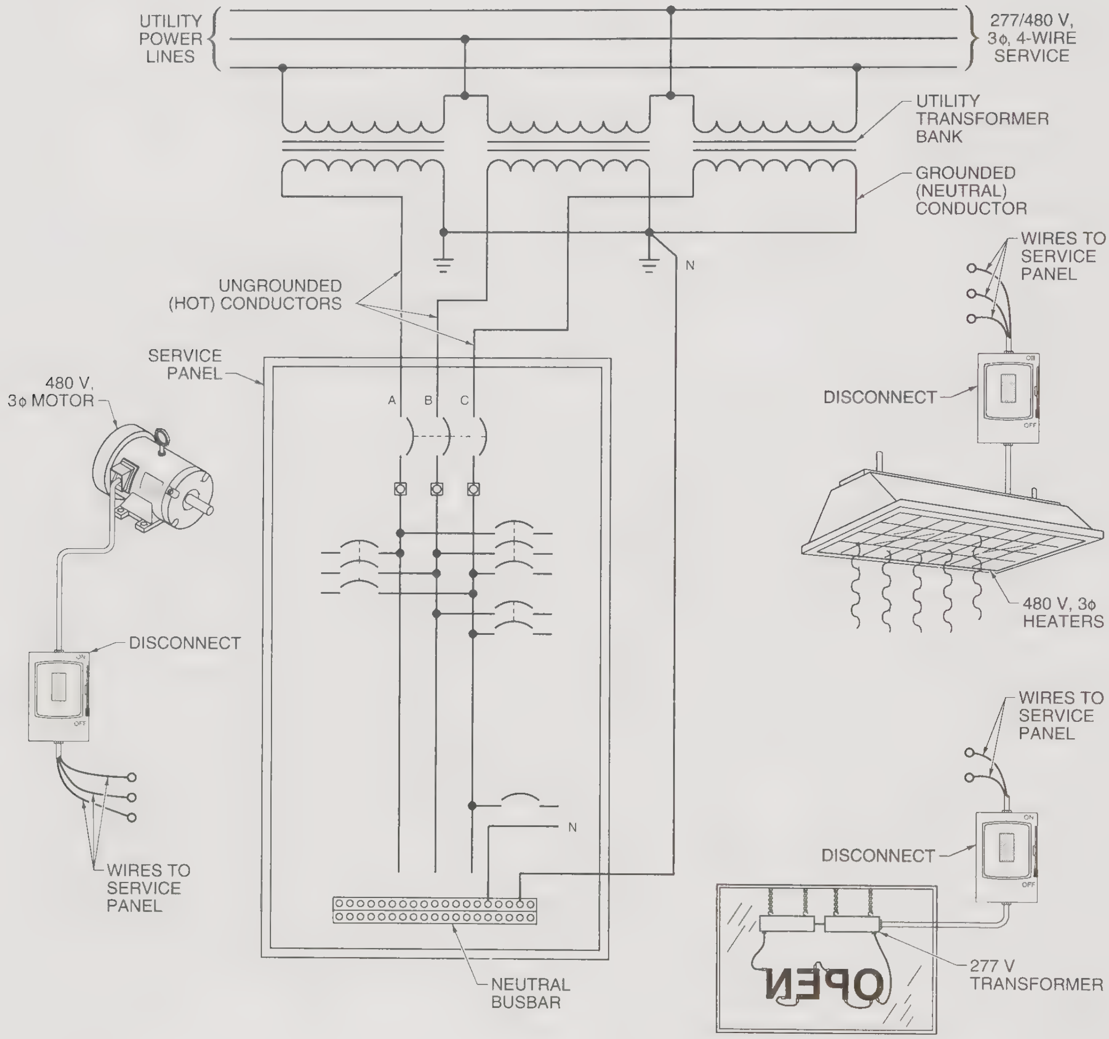
Activity 21-3: 120/240 V, 3ϕ, 4-Wire Service Wiring

1. Connect each load to the service panel.


UTILITY POWER LINES
120/240 V, 3ϕ, 4-WIRE SERVICE
UTILITY TRANSFORMER BANK
A
B
N
C
UNGROUNDED (HOT) CONDUCTORS
GROUNDED (NEUTRAL) CONDUCTOR
PER NEC® 110.15 HIGH LEG B MUST BE ORANGE
240 V, 1ϕ MOTOR
SERVICE PANEL
A B C
DISCONNECT
WIRES TO SERVICE PANEL
N
NEUTRAL BUSBAR
WIRES TO SERVICE PANEL
DISCONNECT
240 V LAMPS
WIRES TO SERVICE PANEL
240 V, 3ϕ LOAD
DISCONNECT
ON
OFF

Activity 21-4: 277/480 V, 3ϕ, 4-Wire Service Wiring

1. Connect each load to the service panel.


UTILITY POWER LINES
277/480 V, 3ϕ, 4-WIRE SERVICE
UTILITY TRANSFORMER BANK
GROUNDED (NEUTRAL) CONDUCTOR
N
UNGROUNDED (HOT) CONDUCTORS
SERVICE PANEL
480 V, 3ϕ MOTOR
A
B
C
WIRES TO SERVICE PANEL
DISCONNECT
480 V, 3ϕ HEATERS
DISCONNECT
WIRES TO SERVICE PANEL
N
DISCONNECT
WIRES TO SERVICE PANEL
NEUTRAL BUSBAR
OPEN
277 V TRANSFORMER

Activity 21-5: Conductor Color Coding

Determine each conductor color using standard conductor color coding.

__________ **1.** Conductor A color = ___

__________ **2.** Conductor B color = ___

__________ **3.** Conductor C color = ___

__________ **4.** Conductor D color = ___

__________ **5.** Conductor E color = ___

__________ **6.** Conductor F color = ___

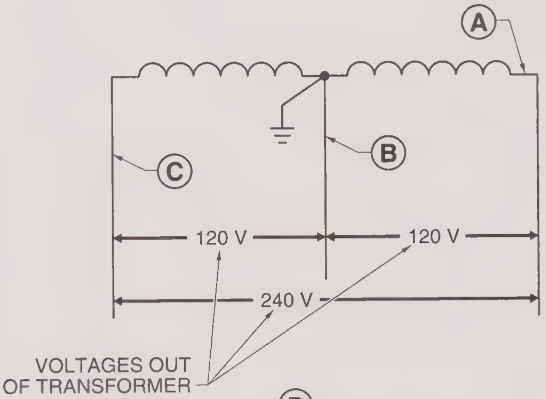
__________ **7.** Conductor G color = ___

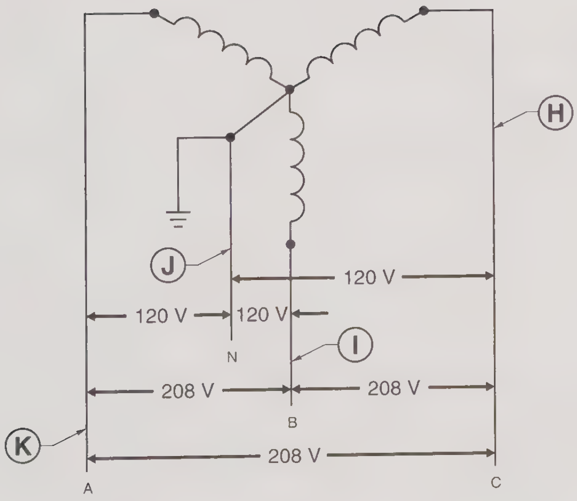
__________ **8.** Conductor H color = ___

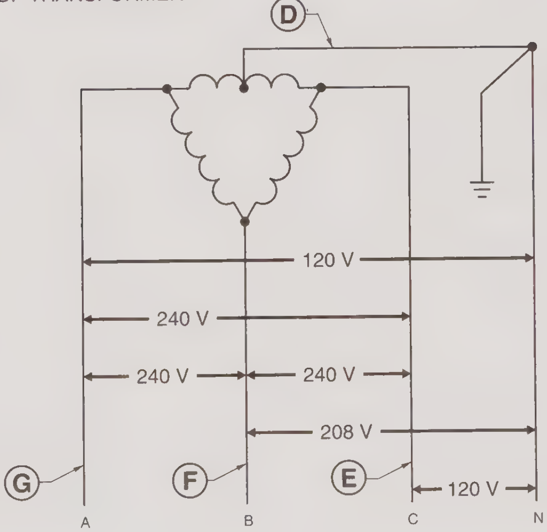
__________ **9.** Conductor I color = ___

__________ **10.** Conductor J color = ___

__________ **11.** Conductor K color = ___


A
C
B
120 V
120 V
240 V
VOLTAGES OUT
OF TRANSFORMER


H
J
120 V
120 V
120 V
N
I
208 V
208 V
B
K
208 V
A
C


D
120 V
240 V
240 V
240 V
208 V
G
F
E
120 V
A
B
C
N

Welding Fundamentals

22

Review

Name ______________________________ Date ____________________

True-False

T F **1.** Welding is forming a material into a whole by uniting parts.

T F **2.** Oxyfuel welding (OFW) is the most common method of welding metals.

T F **3.** Gas metal arc welding (GMAW) can be used to weld various ferrous and nonferrous metals.

T F **4.** In resistance welding, the electrode, the arc, and the weld pool are protected from the atmosphere by a shielding gas.

T F **5.** Plasma arc welding is not commonly used in agricultural mechanics, although plasma arc cutting may occasionally be used.

T F **6.** GMAW is used to make localized (spot) or continuous (seam) welds.

T F **7.** Safety glasses must be worn in the work area and when welding to protect the eyes from slag and other debris that might be deflected under the helmet.

T F **8.** Welding without proper eye protection can cause flash burn.

T F **9.** Auto-darkening helmets darken within one-thousandth of a second when arc light strikes the filter.

T F **10.** In the agricultural industry, welds are used to repair heavy equipment such as trailers, skid steers, tractors, and combines.

T F **11.** The filler metal is the metal part or parts being welded.

T F **12.** A weld pass is a single progression of welding along a weld joint.

T F **13.** Depth of fusion, or depth of penetration, is the distance that fusion extends into the base metal from the surface during welding.

T F **14.** Joint penetration is the distance the weld metal extends into the joint.

T F **15.** Weld width is the distance from toe to toe across the face of the weld.

T F **16.** Base metal is metal deposited in a welded, brazed, or soldered joint during the welding process.

T F **17.** Most agricultural welding involves the use of only a few different types of joints, although there are numerous variations of each type.

T F **18.** Basic butt joint designs are square, single- and double-bevel, and single- and double-J.

T F **19.** Edge joints are used in many applications where welds are exposed to general service loads.

T F **20.** Lap joints can be combined with butt joints or corner joints, and the edges can be squared or beveled.

T F **21.** The weld type is determined by the weld joint design and depends on the load requirements of the weld.

T F **22.** Fillet welds may be used in lap, T, or corner joints.

T F **23.** A groove weld may be square groove, single-groove, or double-groove.

T F **24.** The four basic welding positions are flat, horizontal, vertical, and overhead.

T F **25.** The horizontal position is the most widely used welding position because welding can be done quickly and easily.

Multiple Choice

________________ **1.** The flat welding position is indicated by the number ___.

A. 1
B. 2
C. 3
D. 4

________________ **2.** ___ position welding allows for the greatest control of the welding process.

A. Flat
B. Horizontal
C. Vertical
D. Overhead

________________ **3.** ___ welding uses heat from the combustion of a mixture of oxygen and a fuel gas.

A. Arc
B. Shielded metal arc
C. Resistance
D. Oxyfuel

________ **4.** ___ welding produces an arc between a consumable, coated electrode and the base metal, creating a weld pool.

A. Arc
B. Shielded metal arc
C. Resistance
D. Oxyfuel

________ **5.** ___ welding produces an arc between a nonconsumable tungsten electrode and the base metal, creating a weld pool.

A. Gas tungsten arc
B. Shielded metal arc
C. Plasma arc
D. Oxyfuel

________ **6.** ___ welding uses a constricted arc between a nonconsumable tungsten electrode and the weld pool or between the electrode and constricting nozzle.

A. Gas tungsten arc
B. Shielded metal arc
C. Plasma arc
D. Resistance

________ **7.** ___ welding occurs from the heat created by resistance to the flow of current through the joined metals.

A. Arc
B. Resistance
C. Oxyfuel
D. Flux-cored arc

________ **8.** A ___ is a depression at the termination of a weld bead.

A. gap
B. crater
C. root
D. dip

________ **9.** ___ reinforcement is reinforcement on the same side as the welding.

A. Root
B. Weld
C. Face
D. Joint

________ **10.** ___ is the melting of base metal and filler metal, or base metal only, to make a weld.

A. Fusion welding
B. Depth of fusion
C. Joint penetration
D. none of the above

______________ **11.** A(n) ___ joint is a weld joint in which two parts are set approximately level to each other and positioned edge to edge.

A. edge
B. corner
C. lap
D. butt

______________ **12.** Common ___ joints are flush, half-open, and full-open.

A. edge
B. corner
C. lap
D. butt

______________ **13.** A 2F weld is a ___.

A. flare weld in the horizontal position
B. flare-bevel-groove weld in the overhead position
C. fillet weld in the horizontal position
D. fillet weld in the flat position

______________ **14.** When welding lap joints, an overlap greater than ___ times the thickness of the thinner part is recommended.

A. one
B. two
C. three
D. four

______________ **15.** A ___ is a weld that results from a weld pass.

A. root bead
B. root pass
C. weld cut
D. weld bead

Completion

______________ **1.** A shielded metal arc welding (SMAW) electrode contains ___, which forms a protective slag over the weld.

______________ **2.** ___ welding is welding that joins metals by heating them with an electric arc.

______________ **3.** A(n) ___ is a consumable or nonconsumable component of a welding circuit that conducts current to the arc, molten slag, or base metal.

______________ **4.** ___ welding is an arc welding process that produces an arc between a continuous wire electrode and the base metal, creating a weld pool in the presence of a shielding gas.

______________ **5.** ___ welding is an arc welding process that produces an arc between a continuous tubular electrode with flux in its core and the base metal, creating a weld pool.

____________________ **6.** ___ is a cutting process that uses a constricted arc and high-pressure gas to form a high-velocity jet of plasma (ionized gas) for cutting.

____________________ **7.** A(n) ___ weld is made from both sides of a joint.

____________________ **8.** ___ reinforcement is additional weld metal that is required to completely fill a joint.

____________________ **9.** ___ reinforcement is reinforcement on the back side of the base metal, opposite the face reinforcement.

____________________ **10.** The ___ is the portion of the groove face within the root opening.

____________________ **11.** The ___ is the junction of the base metal and the weld face.

____________________ **12.** A(n) ___ is a weld bead that extends into or includes part or all of the joint root.

____________________ **13.** A(n) ___ weld is a small weld used to hold the parts in proper alignment until the welds are made.

____________________ **14.** A(n) ___ weld is a fusion weld made without filler metal.

____________________ **15.** A(n) ___ joint is the physical configuration at the juncture of the parts to be welded.

____________________ **16.** A(n) ___ is a weld joint formed when two parts are positioned at approximately 90° to each other in the form of a T.

____________________ **17.** A(n) ___ joint is a weld joint between two overlapping parts in parallel planes.

____________________ **18.** A(n) ___ joint is a weld joint formed when the edges of two or more parallel, or nearly parallel, parts are joined.

____________________ **19.** ___ is the cross-sectional shape of the weld after filler metal is added to the joint.

____________________ **20.** A(n) ___ weld is a weld made in the groove between the two parts to be joined.

Short Answer

1. List three criteria that are used to determine the type of welding process selected for a specific job.

2. List five factors in the design of a weld joint that must be considered in order to ensure safety and efficiency.

3. List five example of confined spaces in agricultural locations where welding could be performed.

4. Why should welding never be performed against concrete?

5. List five items of consideration when determining the application of a single-groove weld over a double-groove weld.

Identification

Arc Welding Processes

Identify the arc welding processes.

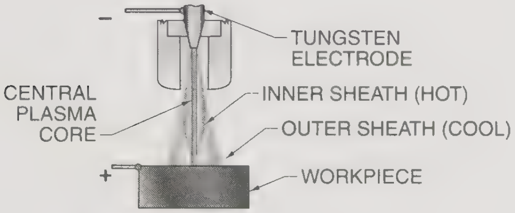
______________ 1. Flux-cored arc welding (FCAW)

______________ 2. Gas metal arc welding (GMAW)

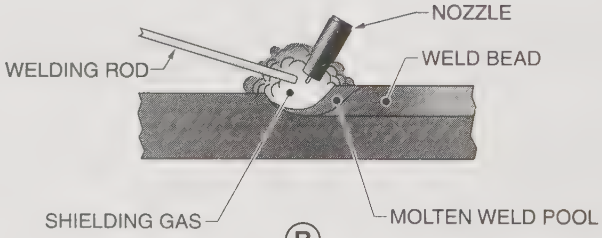
______________ 3. Gas tungsten arc welding (GTAW)

______________ 4. Plasma arc welding and cutting (PAW)

______________ 5. Shielded metal arc welding (SMAW)


–
TUNGSTEN ELECTRODE
CENTRAL PLASMA CORE
INNER SHEATH (HOT)
OUTER SHEATH (COOL)
+
WORKPIECE

Ⓐ


NOZZLE
WELDING ROD
WELD BEAD
SHIELDING GAS
MOLTEN WELD POOL

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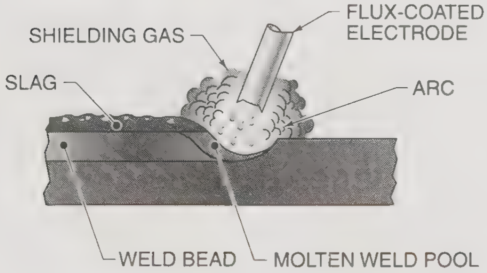
SHIELDING GAS
FLUX-COATED ELECTRODE
SLAG
ARC
WELD BEAD
MOLTEN WELD POOL

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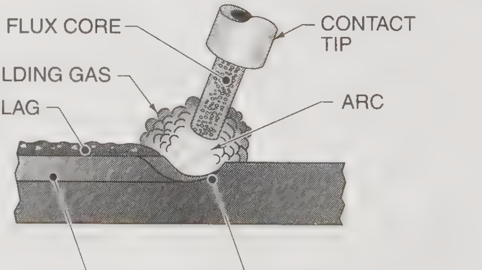
FLUX CORE
CONTACT TIP
SHIELDING GAS
SLAG
ARC
WELD BEAD
MOLTEN WELD POOL

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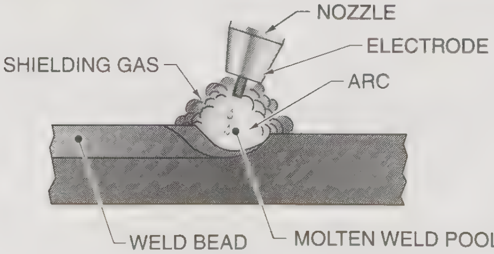

NOZZLE
ELECTRODE
SHIELDING GAS
ARC
WELD BEAD
MOLTEN WELD POOL

Ⓔ

Protective Clothing

Identify the protective clothing.

____________________ **1.** Buttoned collar

____________________ **2.** Heavy-duty leather gauntlet-type gloves

____________________ **3.** Helmet

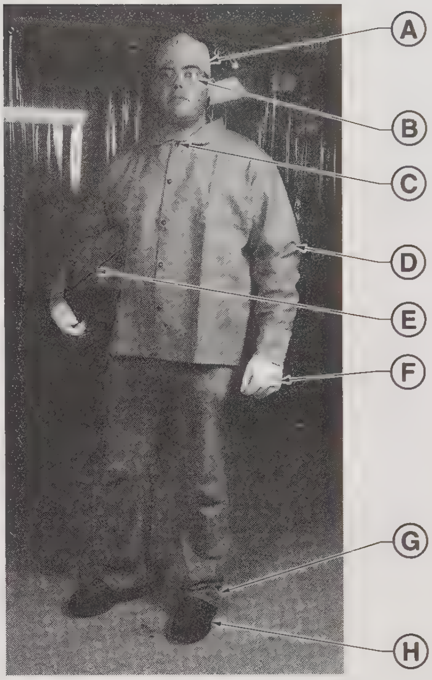
____________________ **4.** Leather welding jacket

____________________ **5.** Safety glasses

____________________ **6.** Steel-toed work boots

____________________ **7.** Sturdy pants

____________________ **8.** Welding cap



Weld Joints

Identify the weld joints.

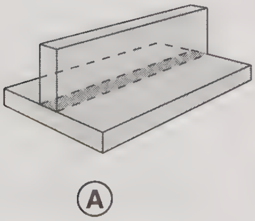
____________________ **1.** Butt

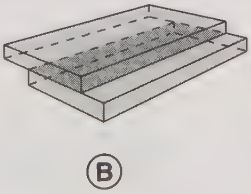
____________________ **2.** Corner

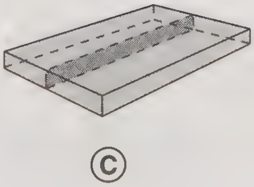
____________________ **3.** Edge

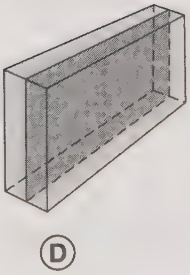
____________________ **4.** Lap

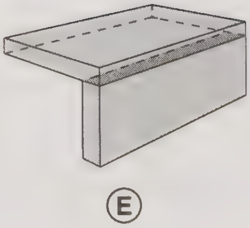
____________________ **5.** T











Butt Joints

Identify the butt joints.

______________ **1.** Double-bevel-groove

______________ **2.** Double-J-groove

______________ **3.** Double-U-groove

______________ **4.** Double-V-groove

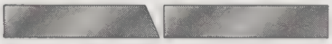
______________ **5.** Single-bevel-groove

______________ **6.** Single-J-groove

______________ **7.** Single-U-groove

______________ **8.** Single-V-groove

______________ **9.** Square-groove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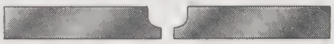
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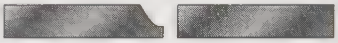
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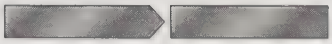
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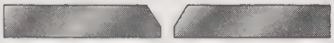
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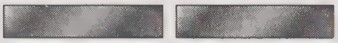
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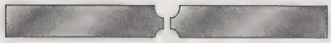
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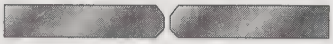
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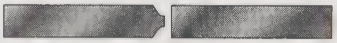
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T-Joints

Identify the T-joints.

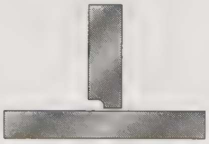
______________ **1.** Double-bevel

______________ **2.** Double-J

______________ **3.** Single-bevel

______________ **4.** Single-J

______________ **5.** Square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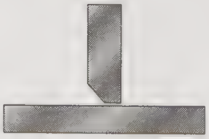
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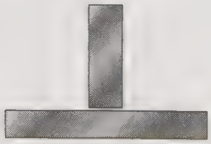
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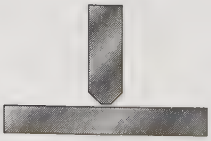
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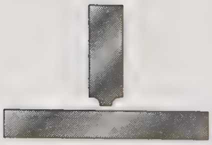
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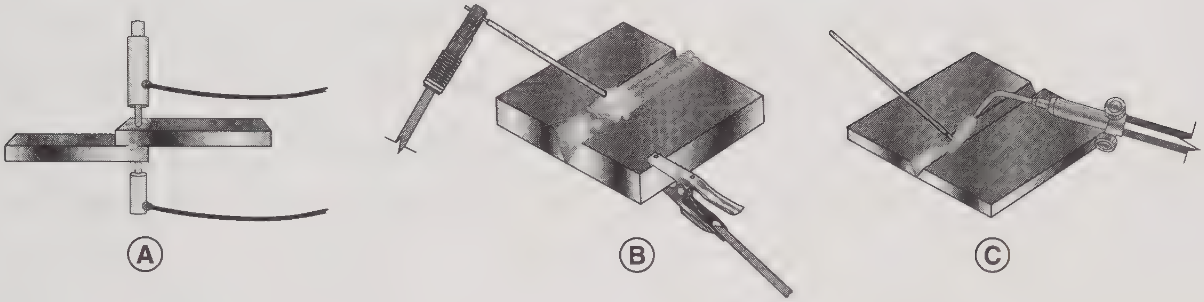
Welding Processes

Identify the welding processes.

______________ **1.** Arc welding (AW)

______________ **2.** Oxyfuel Welding (OFW)

______________ **3.** Resistance welding (RW)



Root Openings

Identify the root openings.

______________ **1.** Base metal

______________ **2.** Face reinforcement

______________ **3.** Groove face

______________ **4.** Joint root

______________ **5.** Root face

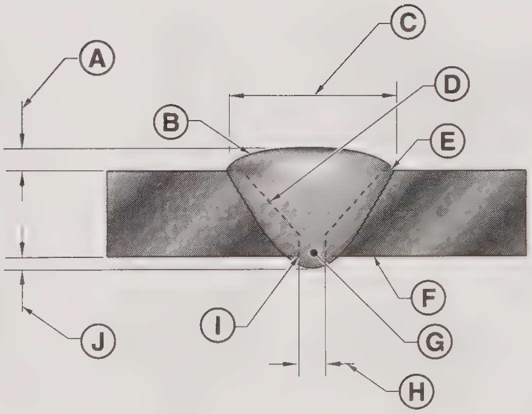
______________ **6.** Root opening

______________ **7.** Root reinforcement

______________ **8.** Weld face

______________ **9.** Weld toe

______________ **10.** Weld width



Weld Joints and Positions

Identify the weld joints and positions.

__________ **1.** Butt, flat (1G)

__________ **2.** Butt, horizontal (2G)

__________ **3.** Butt, overhead (4G)

__________ **4.** Butt, vertical (3G)

__________ **5.** Corner, flat (1F)

__________ **6.** Corner, horizontal (2F)

__________ **7.** Corner, overhead (4F)

__________ **8.** Corner, vertical (3F)

__________ **9.** Edge, flat (1G)

__________ **10.** Edge, horizontal (2G)

__________ **11.** Edge, overhead (4G)

__________ **12.** Edge, vertical (3G)

__________ **13.** Lap, flat (1F)

__________ **14.** Lap, horizontal (2F)

__________ **15.** Lap, overhead (4F)

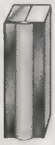
__________ **16.** Lap, vertical (3F)

__________ **17.** T, flat (1F)

__________ **18.** T, horizontal (2F)

__________ **19.** T, overhead (4F)

__________ **20.** T, vertical (3F)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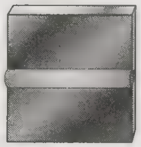
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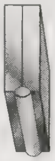
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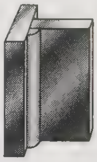
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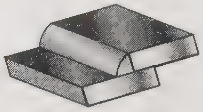
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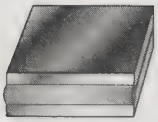
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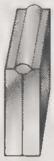
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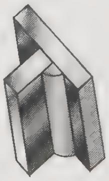
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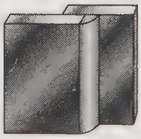
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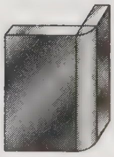
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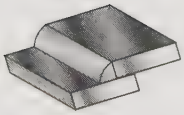
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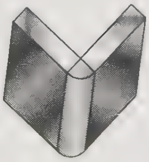
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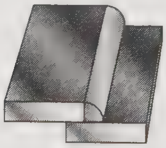
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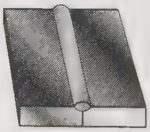
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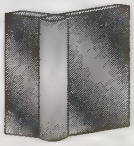
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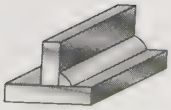
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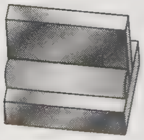
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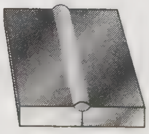
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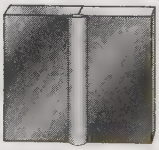
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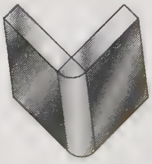
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Corner, Edge, and Lap Joints

Identify the corner, edge, and lap joints.

______________ **1.** Double-bevel edge

______________ **2.** Fillet weld on both sides

______________ **3.** Fillet weld on one side

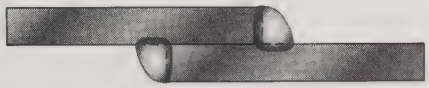
______________ **4.** Flush corner

______________ **5.** Full-open corner

______________ **6.** Half-open corner

______________ **7.** Single-bevel edge

______________ **8.** Square edge



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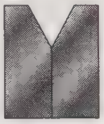

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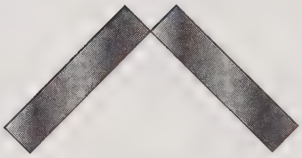

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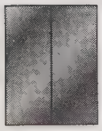

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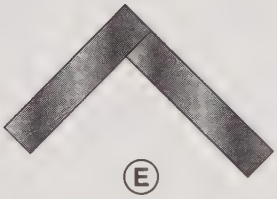

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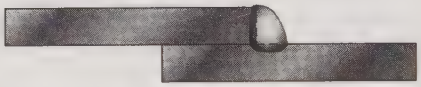

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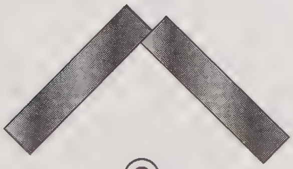

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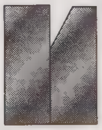

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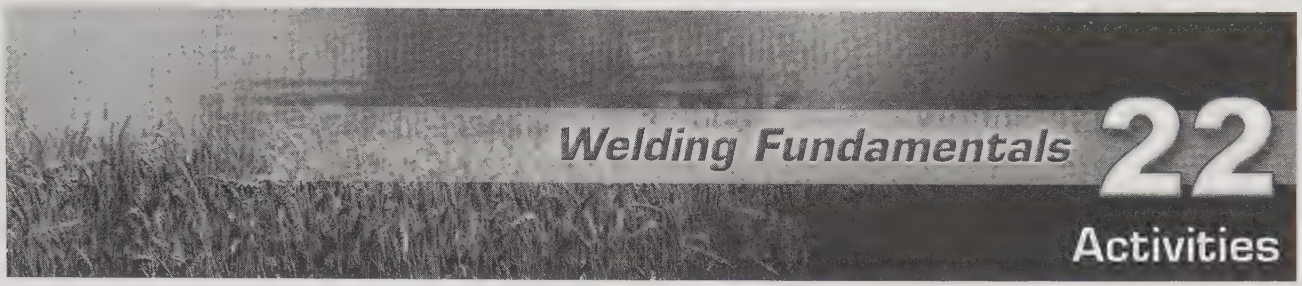


Welding Fundamentals 22

Activities

Name ______________________________ Date ____________________

Activity 22-1: Welding Safety

1. List welding safety considerations and PPE. Include a plan to keep yourself and others safe in a welding shop or field environment.

Oxyfuel Welding and Joining

23

Review

Name ______________________________ **Date** ________________

True-False

T F **1.** The protector cap must always be on a gas cylinder when the cylinder is not in use.

T F **2.** Oxygen cylinders should never be laid horizontally, as the corrosive nature of the acetone can erode the seals in the tanks.

T F **3.** When handling oxygen and acetylene cylinders, it is required to avoid exposing the cylinders to furnace heat, radiators, open fire, or sparks from a torch.

T F **4.** Regulators are equipped with a cylinder pressure gauge, which indicates the pressure in the cylinder.

T F **5.** The working pressure for acetylene must never exceed 17 psi.

T F **6.** A special permeable hose is used to connect the oxygen and acetylene supply to the torch.

T F **7.** Welding hoses are impervious to grease and oil.

T F **8.** Leaking hoses must be replaced, not repaired.

T F **9.** A welding tip is designed to be installed and removed with a specialized wrench.

T F **10.** Matches, lighters, or hot metal must never be used to light a welding torch because the flame produced by acetylene can cause serious burns.

T F **11.** On oxyacetylene welding (OAW) equipment, the green hose is connected to the acetylene check valve mounted on the needle valve fitting marked AC.

T F **12.** All new welding equipment must be tested for leaks before being operated.

T F **13.** Noises, such as hissing sounds, or bubbles are an indication of a leak on OAW equipment.

T F **14.** When igniting a welding torch, the psi should never exceed 17.

T F **15.** To adjust the flame after the acetylene is ignited and adjusted, the oxygen needle valve should be opened gradually.

T F **16.** An oxidizing flame is used for most welding operations.

T F **17.** When excess acetylene is forced into the oxyacetylene mixture, the resulting flame is oxidizing.

T F **18.** Cutting metal using a flame is common in many industrial, construction, and fabrication applications.

T F **19.** When performing oxyfuel cutting operations, the cutting of metal occurs when ferrous metals are subjected to rapid oxidation.

T F **20.** Because it typically occurs naturally, the rusting process tends to be quick.

T F **21.** Too much fuel in relation to oxygen produces a carburizing flame.

T F **22.** OAW is only suitable for carbon steel applications.

T F **23.** A major benefit of soldering is that low temperatures are used, so there is minimum effect on base metal properties.

T F **24.** An oxyhydrogen mixture, because of the low heat it produces, is used for brazing aluminum and other nonferrous metals.

T F **25.** There are ten basic steps required to perform braze welding.

Multiple Choice

________________ **1.** ___ welding is a welding process that uses acetylene as the fuel gas.

A. Oxyfuel
B. Oxyacetylene
C. Shielded metal arc
D. Gas metal arc

________________ **2.** ___ welding can be used to join iron, steel, cast iron, copper, brass, aluminum, bronze, and other metals.

A. Oxyacetylene
B. Oxyfuel
C. Shielded metal arc
D. Gas metal arc

________________ **3.** Oxygen and acetylene cylinders are available in a size containing ___ cu ft of gas.

A. 96
B. 144
C. 244
D. 312

________________ **4.** Acetone is a liquid chemical that stabilizes acetylene and allows the cylinder to be pressurized to ___ psi.

A. 50
B. 150
C. 250
D. 350

____________________ **5.** When handling oxygen and acetylene cylinders, the maximum safe operating pressure for acetylene is ____ psi.

A. 12
B. 13
C. 14
D. 15

____________________ **6.** Acetylene hoses are red, while oxygen hoses are ____.

A. blue
B. green
C. orange
D. black

____________________ **7.** The required working pressure for acetylene must be between 1 psi and ____ psi.

A. 12
B. 17
C. 25
D. 40

____________________ **8.** To assemble OAW equipment, first ____.

A. crack the cylinder valves by opening and closing them quickly to remove debris
B. connect the oxygen regulator to the oxygen cylinder and the oxygen hose to the oxygen regulator
C. connect the check valves and hoses to the torch
D. test for leaks

____________________ **9.** When performing OAW work, the distance between the inner cone of the flame and the puddle of molten metal should be ____″.

A. ⅛
B. ¼
C. ½
D. ¾

____________________ **10.** The oxygen in the fuel mixture used for oxyfuel cutting must be ____% pure.

A. 97
B. 98
C. 99
D. 100

____________________ **11.** Parts that have been soldered must be washed in a(n) ____ bath to eliminate the corrosive action of the flux.

A. cold water
B. cold water/vinegar
C. hot water
D. alcohol

________ **12.** ___ is the process of joining metal using capillary action to distribute a filler metal (solder) that has a melting point less than the melting point of the base metal but not greater than 840°F.

A. Braze welding (BAW)
B. Soldering (S)
C. Brazing (B)
D. Oxyacetylene welding (OAW)

________ **13.** ___ is the primary method of making joints in electrical and electronic circuits.

A. Braze welding (BAW)
B. Soldering (S)
C. Brazing (B)
D. Plastic welding

________ **14.** Gas cylinders in storage must be separated from combustible materials by a minimum distance of ___″.

A. 12
B. 16
C. 20
D. 24

________ **15.** A(n) ___ mixture uses oxygen and city gas, bottled gas, propane, or butane.

A. MAPP-oxygen
B. gas-oxygen
C. air-gas
D. oxyacetylene

Completion

________ **1.** ___ welding is a welding process that uses heat from the combustion of a mixture of oxygen and a fuel gas such as acetylene, methylacetylene-propadiene (MAPP), propane, natural gas, hydrogen, or propylene.

________ **2.** ___ contain pressurized gases and provide storage until the gases are used in the welding process.

________ **3.** ___ cylinders are packed with a porous material that is saturated with acetone to ensure safe storage and transport.

________ **4.** ___ should never be used on gas cylinders, regulators, connections, or hoses because it can deteriorate seals, gaskets, and rubber hoses.

________ **5.** ___ are equipped with a working-pressure gauge, which shows the working, or line, pressure used at the torch.

________ **6.** A(n) ___ is used to squeeze the hose, which attaches the regulator and torch, around the nipple to prevent it from working loose.

________ **7.** A(n) ___ is a tool that mixes gas in the correct proportions and permits the mixture to flow to a tip where it is burned.

__________ **8.** Frequent torch use causes carbon to form in the passage of the ___.

__________ **9.** A(n) ___ is a tool used for igniting a welding torch.

__________ **10.** On ___ equipment, the green hose is connected to the check valve mounted on the needle valve fitting marked OX.

__________ **11.** A(n) ___ flame has an approximate one-to-one mixture of acetylene and oxygen and therefore has neither oxidizing nor carburizing characteristics.

__________ **12.** A(n) ___ flame is a flame in which there is an excess of oxygen.

__________ **13.** If the ___ mixture consists of a slight excess of acetylene, the flame is carburizing, or reducing.

__________ **14.** When heat from the oxyacetylene flame is directed to the weld area, a depression of ___ is formed.

__________ **15.** ___ is a group of cutting processes that use heat generated by an oxyfuel gas flame.

__________ **16.** Copper and ___ materials form similar high-melting-point oxides and possess high thermal conductivity, making it difficult for them to be heated sufficiently for oxyfuel cutting.

__________ **17.** ___ is the force that distributes liquid filler metal between the surfaces of a joint that are close together.

__________ **18.** ___ is the process of joining metal using capillary action to distribute a filler metal (solder) that has a melting point less than the melting point of the base metal but greater than 840°F.

__________ **19.** ___ is a material used to outline areas that are not to be brazed.

__________ **20.** ___ is a joining process that uses filler metal, brass, or a bronze alloy at temperatures greater than 840°F but less than the melting point of the base metal.

Short Answer

1. Explain how and why the design of hoses for oxygen and acetylene gases is such that they cannot be connected to the incorrect gas supply or side of a cutting torch.

2. What occurs when the oxygen purity of the fuel gas mixture is reduced during oxyfuel cutting?

3. Explain the process for properly cleaning a torch tip.

4. Explain why oxygen cylinders are equipped with a safety nut and how it is used.

5. What is the basis for selecting filler rods for specific welding jobs?

Identification

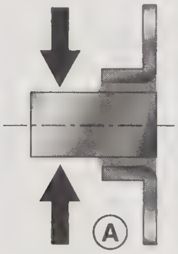
Brazed Joints

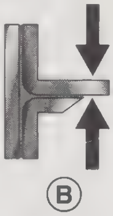
Identify the stress on the brazed joints. Note: A level of stress may be shown more than once.

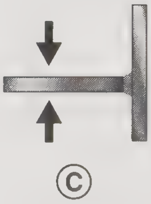
______________ **1.** Low stress

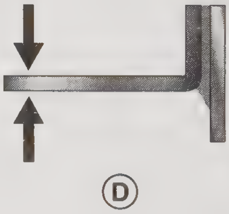
______________ **2.** Medium stress

______________ **3.** High stress









Gas Cylinders

Identify the gas cylinder components.

______________ **1.** Acetylene cylinder

______________ **2.** Acetylene cylinder valve

______________ **3.** Acetylene regulator inlet connection

______________ **4.** Hose connections at regulators and torch

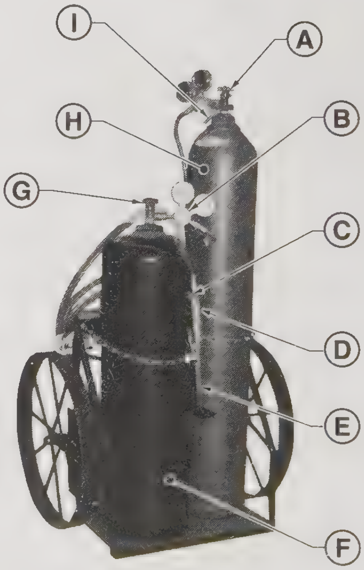
______________ **5.** Oxygen and acetylene needle valves

______________ **6.** Oxygen cylinder

______________ **7.** Oxygen cylinder valve

______________ **8.** Oxygen regulator inlet connection

______________ **9.** Welding torch



Oxyfuel Welding and Joining 23

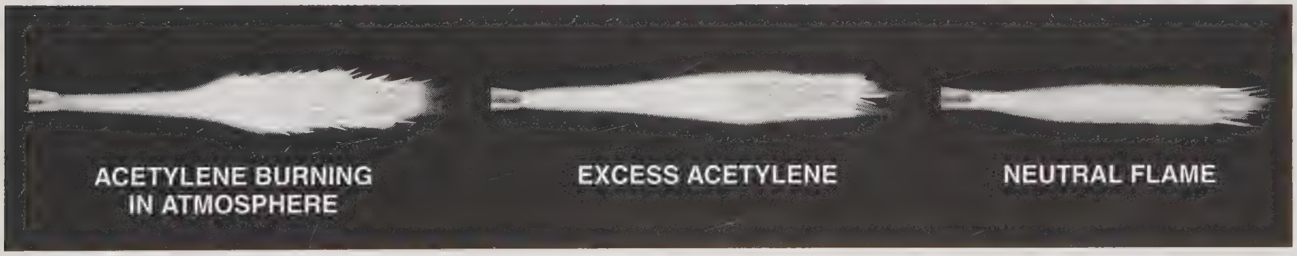
Activities

Name ______________________________ Date ____________________

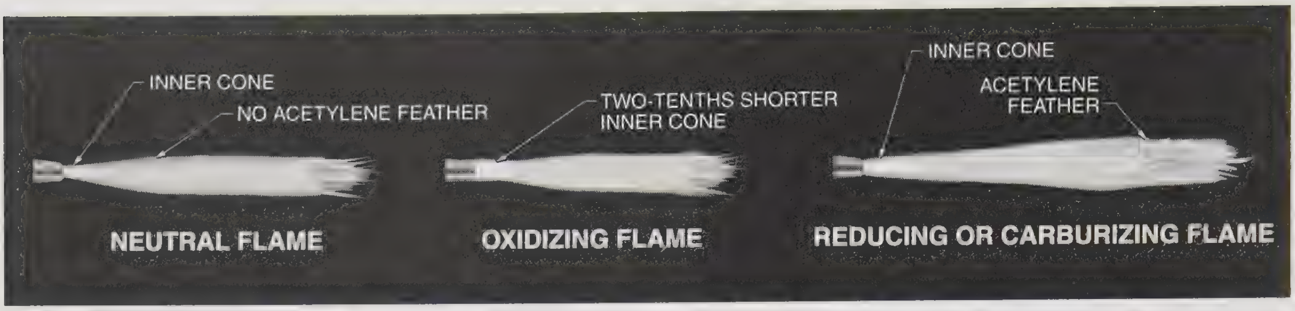
Activity 23-1: Lighting the Torch

Practice lighting an oxyacetylene welding torch by applying the following procedure.

1. Mount a number 0 welding tip on the welding torch. Turn the regulator adjusting screws all the way out.
2. Stand to one side and open the oxygen and acetylene cylinder valves slowly. The oxygen cylinder valve should be opened all the way and the acetylene cylinder valve should be opened approximately one-quarter of a turn to one complete turn.
3. Stand to the side and turn the regulator adjusting screws to obtain the required working pressures.
4. Open the acetylene needle valve on the torch approximately one-quarter of a turn.
5. With the welding tip pointing down, position the sparklighter approximately 1″ from the end of the tip. Ignite the flame quickly to prevent wasting acetylene.
6. Adjust the flame so that it jumps slightly away from the torch tip. If the flame produces a great amount of black smoke, increase the amount of acetylene by opening the acetylene needle valve.
7. With the acetylene burning, slowly open the oxygen needle valve to produce a neutral flame. An excess amount of oxygen will produce an oxidizing flame. An excess amount of acetylene will produce a carburizing flame.



8. To shut off the torch, close the oxygen needle valve first.
9. Promptly close the acetylene valve.
10. Close the oxygen and acetylene cylinder valves to shut down the entire welding apparatus.
11. To remove pressure on the regulators, open the oxygen needle valve on the torch, and then open the acetylene needle valve. Close the needle valves when no pressure is indicated on the regulators.
12. Turn out the adjusting screws on the regulators to release pressure on the regulator.


INNER CONE
NO ACETYLENE FEATHER
TWO-TENTHS SHORTER INNER CONE
INNER CONE
ACETYLENE FEATHER
NEUTRAL FLAME
OXIDIZING FLAME
REDUCING OR CARBURIZING FLAME

13. Obtain a neutral, carburizing, and oxidizing flame by increasing or decreasing the flow of oxygen and/or acetylene.
14. Identify the characteristics of the flame.
15. Apply each flame to metal and observe the results of each.

Activity 23-2: Carrying a Weld Pool without Filler Metal Using OAW

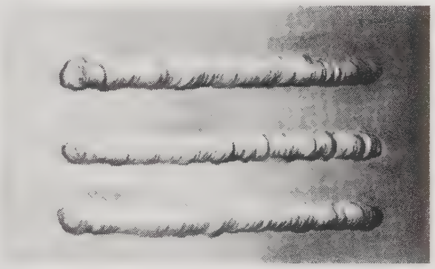
Practice carrying a weld pool without filler metal by applying the following procedure.

1. Be sure the surface of the workpiece is free of oil, dirt, and scale.
2. Light the torch and adjust for a neutral flame.
3. Hold the torch at a 45° angle with the inner cone of the flame ⅛″ from the workpiece.
4. Use a circular motion with the torch to distribute the heat evenly. Start from the right side of the piece, moving to the left. (If left-handed, start from the left side of the piece, moving to the right.)
5. Maintain a consistent travel speed to prevent melt-through in the workpiece.
6. Practice depositing beads approximately ⅜″ apart until properly formed beads are produced consistently.

Activity 23-3: Depositing Beads with Filler Metal Using OAW

Practice depositing beads with filler metal by applying the following procedure.

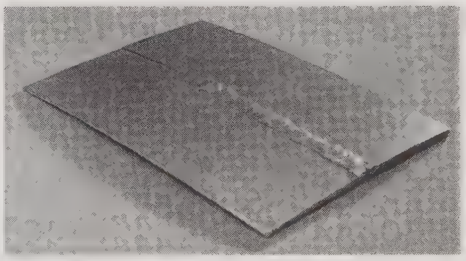
Note: Weld beads should run parallel to the length of the workpiece and be consistent in width, ripple formation, and penetration.



1. Be sure the surface of the workpiece is free of oil, dirt, and scale.
2. Light the torch and adjust for a neutral flame.
3. Hold the torch at a 45° angle with the inner cone of the flame ⅛″ from the workpiece.
4. Use a circular motion with the torch to distribute the heat evenly. Start from the right side of the piece, moving to the left. (If left-handed, start from the left side of the piece, moving to the right.)
5. Maintain a consistent travel speed to prevent melt-through in the workpiece.
6. Maintain a 45° angle to the workpiece with the torch and the filler metal.
7. Dip the filler metal into the weld pool with an in-and-out motion while manipulating the torch.
8. At the end of the weld, withdraw the torch slightly from the workpiece and fill the crater by dipping the filler metal into the weld pool.
9. Practice depositing beads approximately ⅜″ apart until properly formed beads are produced consistently.

Activity 23-4: Welding a Butt Joint in Flat Position Using OAW

Practice welding a butt joint in the flat position by applying the following procedure.

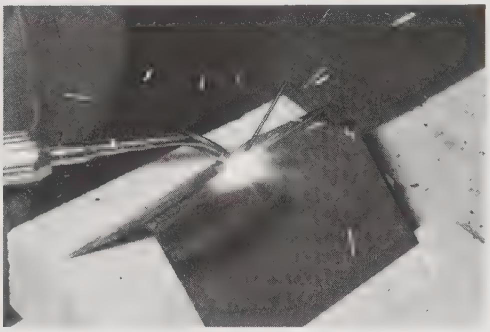


1. Tack weld the workpieces to form a butt joint. Allow a gap of 1⁄16″.
2. Use the same motion with the torch and filler metal as practiced when depositing beads with filler metal. Add sufficient filler metal to build up the weld bead approximately 1⁄16″ above the surface of the workpiece.
3. Maintain a weld pool approximately ¼″ to ⅜″ wide.
4. Advance the torch approximately 1⁄16″ with each rotation of the torch movement to maintain consistent bead width.
5. Fill the crater at the end of the weld to prevent a weak spot in the weld.

Activity 23-5: Welding a Corner Joint in Flat Position Using OAW

Practice welding a corner joint in the flat position by applying the following procedure.

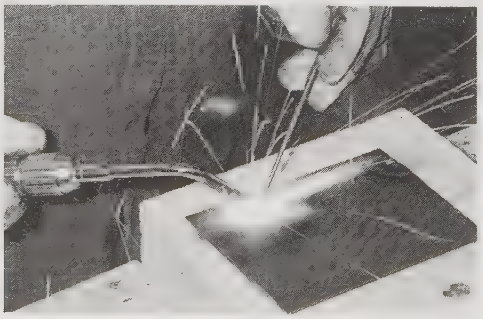
1. Tack weld the two workpieces to form a corner joint.
2. Hold the torch on the starting end until a weld pool is formed.
3. Carefully manipulate the torch to maintain a consistent weld pool across the joint.
4. Withdraw the torch at the end of the joint to prevent burning a hole in the joint.
5. If additional build-up is required, filler metal may be added as the weld pool is carried across the joint.



Activity 23-6: Welding a Lap Joint in Flat Position Using OAW

Practice welding a lap joint in the flat position by applying the following procedure.

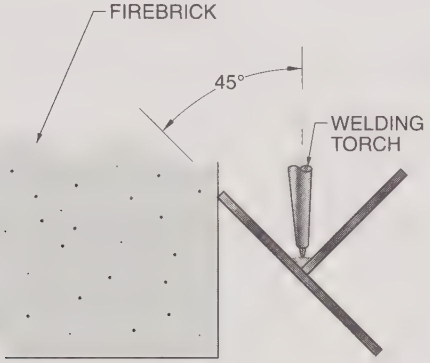
1. Tack weld the two workpieces to form a lap joint.
2. Place a firebrick under the bottom workpiece to obtain the flat position.
3. Use a semicircular motion with the torch. Direct more of the welding heat to the bottom workpiece by increasing the duration of the torch movement on the bottom workpiece. This will prevent overheating of the top workpiece.
4. Weld one side of the joint and repeat the weld on the other side.



Activity 23-7: Welding a T-Joint in Flat Position Using OAW

Practice welding a T-joint in the flat position by applying the following procedure.

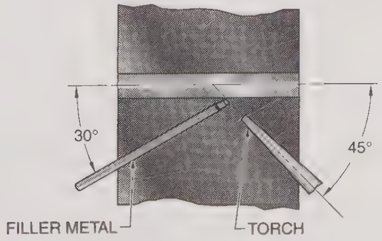
1. Tack weld the two workpieces to form a T-joint.
2. Place a firebrick under one side to obtain the flat position.
3. Hold the torch at a 45° angle to the bottom workpiece.
4. Use the same technique used for welding a lap joint, but direct the heat from the torch equally to both workpieces.
5. Use a semicircular torch movement to distribute the weld metal and prevent undercutting.



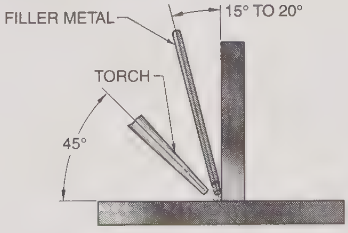
Activity 23-8: Welding a T-Joint in Horizontal Position Using OAW

Practice welding a T-joint in the horizontal position by applying the following procedure.

1. Tack weld the two workpieces to form a T-joint.
2. Hold the torch at a 45° angle to the bottom workpiece.
3. Use the same technique used for welding a lap joint, but direct the heat from the torch equally to both workpieces.
4. Use a semicircular torch movement to distribute the weld metal and prevent undercutting.
5. Add filler metal to the vertical piece to prevent undercutting.



TOP VIEW



END VIEW

Activity 23-9: Welding a T-Joint in Vertical Position Using OAW

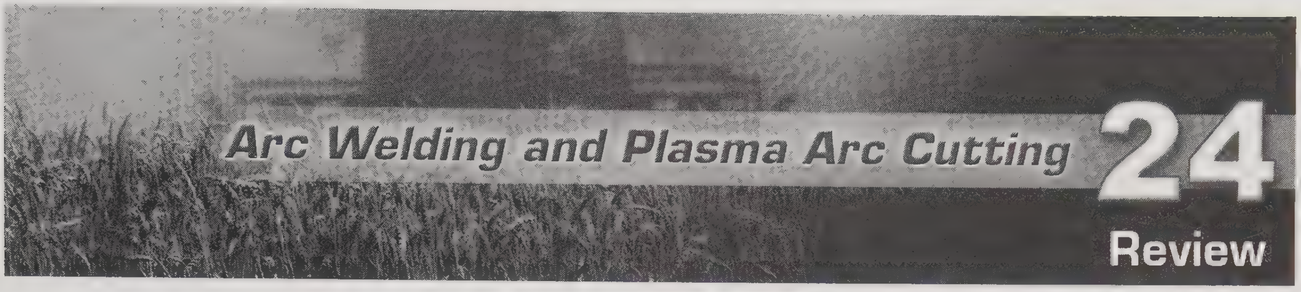
Practice welding a T-joint in the vertical position by applying the following procedure.

1. Tack weld the two workpieces to form a T-joint. Position the workpiece so the weld joint is in the vertical position.
2. Start the weld at the bottom edge and work upward.
3. Hold the torch and filler metal at the same angle as when welding in the flat position.
4. Use a crescent motion with the torch to properly fill the joint. Direct the flame more toward the filler metal to control the weld pool and the filler metal deposited.

Activity 23-10: Welding a Butt Joint in Overhead Position Using OAW

Practice welding a butt joint in the overhead position by applying the following procedure.

1. Tack weld the two workpieces to form a butt joint. Position the workpiece so the weld joint is in the overhead position.
2. Use the same technique as for welding in the flat position, except use a circular motion with the filler metal. This motion helps distribute the deposited weld and prevents drops of metal from falling from the weld area.
3. Watch the flame closely. If the weld pool begins to run, withdraw the torch slightly.



Arc Welding and Plasma Arc Cutting

24

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** Gas metal arc welding (GMAW) is sometimes referred to as stick welding.

T F **2.** Direct current electrode positive (DCEP) is the flow of current from the work (–) to the electrode (+).

T F **3.** A generator welding machine is a welding machine that produces a low-voltage high-current DC output.

T F **4.** The two parts of the shielded metal arc welding (SMAW) electrode are the wire and flux.

T F **5.** The letter E indicates the electrode is to be used with an electric welding machine.

T F **6.** The SMAW process begins by striking an arc.

T F **7.** The push travel angle is the travel angle in which the electrode points away from the direction of travel.

T F **8.** Because there is no interruption in the welding process to replace used electrodes, SMAW is well suited for repair work on mobile agricultural power equipment such as trailers and exhaust systems.

T F **9.** One of the most significant limitations of SMAW is the need to restrict air movement in the weld zone.

T F **10.** Shielding gases commonly used in GMAW include argon, carbon dioxide, helium, and oxygen.

T F **11.** The GMAW process offers advantages over other welding processes, such as no flux and no slag produced and less starting and stopping to change electrodes.

T F **12.** DCEP is commonly used in the GMAW process.

T F **13.** Globular transfer is metal transfer in which molten metal from a consumable electrode is sprayed across the arc in small drops.

T F **14.** A pull angle provides less penetration than a push angle.

T F **15.** The two variations of flux-cored arc welding (FCAW) are self-shielded flux-cored arc welding (FCAW-S) and gas-shielded flux-cored arc welding (FCAW-G).

T F **16.** A pull-type wire feeder is most commonly used with flux-cored electrodes because of their rigidity.

T F **17.** More skill by the welder is required for gas tungsten arc welding (GTAW) than is required for GMAW or SMAW.

T F **18.** Most ferrous metals are welded using DCEP.

T F **19.** A GTAW torch can be either gas-cooled or water-cooled, depending on the amount of current used.

T F **20.** Tungsten only melts when correct procedures are followed.

T F **21.** GTAW can only be performed with filler metal.

T F **22.** The GTAW procedure varies slightly depending on the base metal, weld joint, weld type, and position.

T F **23.** Plasma arc cutting (PAC) is a cutting process that uses a constricted arc and high-pressure gas to form a high-velocity jet of plasma (ionized gas) for cutting metal.

T F **24.** PAC produces intense heat and arc radiation.

T F **25.** OFC produces a narrower kerf than PAC.

Multiple Choice

______________ **1.** A(n) ___ welding machine is a welding machine that produces DC current only.
A. inverter
B. generator
C. transformer
D. plasma

______________ **2.** A well-designed electrode holder will be well-balanced to reduce excessive fatigue while welding and will ___.
A. heat rapidly
B. secure and release electrodes easily
C. be noninsulated
D. be heavy

______________ **3.** When using the American Welding Society (AWS) classification system, the last digit on the electrode indicates the ___.
A. tensile strength of the electrode
B. type of coating and current of the electrode
C. composition of the flux on the electrode
D. welding position

________________ **4.** When performing FCAW operations, a water-cooled welding gun is required when welding at greater than ___ A.

A. 100
B. 300
C. 500
D. 600

________________ **5.** The ___ angle is the angle between the electrode and the weld axis.

A. electrode
B. drag travel
C. push travel
D. travel

________________ **6.** The ___ angle is the angle in which the electrode points toward the direction of travel.

A. electrode
B. drag travel
C. push travel
D. travel

________________ **7.** When performing SMAW operations, to increase the size of the weld puddle, the electrode must be moved ___.

A. faster
B. slower
C. higher
D. lower

________________ **8.** ___ arc welding is an arc welding process that produces an arc between a continuous wire electrode and the base metal, creating a weld pool in the presence of a shielding gas.

A. Shielded metal
B. Gas metal
C. Flux-cored
D. Gas tungsten

________________ **9.** ___ can be push, pull, or push-pull, depending on the location of the drive rollers.

A. Electrode holders
B. Torches
C. Wire feeders
D. Welding guns

________________ **10.** The most common shielding gases used in agricultural welding projects are carbon dioxide and a mixture of carbon dioxide and argon, typically a ratio of ___% argon and ___% carbon dioxide.

A. 75; 25
B. 25; 75
C. 85; 15
D. 15; 85

______ **11.** The ___ determines the current and polarity best suited for an electrode.

A. diameter
B. flux composition
C. length
D. type of workpiece

______ **12.** ___ transfer is the transfer of molten metal in large droplets from the electrode across an arc to the base metal.

A. Short circuit
B. Spray
C. Globular
D. Liquid

______ **13.** ___ arc welding is an arc welding process that produces an arc between a nonconsumable tungsten electrode and the base metal, creating a weld pool.

A. Shielded metal
B. Gas metal
C. Flux-cored
D. Gas tungsten

______ **14.** With an FCAW electrode, the letter ___ indicates that the electrode meets the minimum impact resistance requirements.

A. H
B. I
C. J
D. M

______ **15.** Changes in current on a GMAW welding machine are made by changing the ___.

A. voltage level
B. current level
C. machine resistance
D. wire speed

Completion

______ **1.** ___ arc welding is a process that produces an arc between a consumable, coated electrode and the base metal, creating a weld pool.

______ **2.** ___ is the flow of current from the electrode (–) to the work (+).

______ **3.** A(n) ___ welding machine connects to an electrical power source and uses a transformer to lower voltage while increasing the current to appropriate levels for welding.

______ **4.** A(n) ___ is a device that holds an electrode during welding.

______ **5.** A(n) ___ is the component of the welding circuit that conducts electric current to the weld area.

______________ **6.** Electrodes are identified using the ___ classification system.

______________ **7.** The ___ angle is the angle formed between the electrode and the part measured perpendicular to the direction of travel.

______________ **8.** ___ is the distance from the tip of the electrode core wire to the weld pool.

______________ **9.** ___ is the rate at which an electrode moves along a weld joint.

______________ **10.** A(n) ___ gas is a gas that will not readily combine with other elements.

______________ **11.** In a(n) ___ type wire feeder, the electrode is fed through the welding cable and pulled by drive rollers located on the welding gun.

______________ **12.** A(n) ___ regulates the flow of shielding gas.

______________ **13.** ___ transfer is metal transfer in which molten metal from a consumable electrode is deposited during repeated short circuits.

______________ **14.** ___ transfer is used primarily on thick metal workpieces in flat and horizontal positions.

______________ **15.** ___ arc welding produces an arc between a continuous tubular electrode with flux in its core and the base metal, creating a weld pool.

______________ **16.** ___ arc welding is a process in which auxiliary shielding gas is supplied from an external source through the welding gun cable, gas diffuser, and flux core of the electrode.

______________ **17.** A nonferrous metal welding process that uses AC with superimposed HF is known as ___.

______________ **18.** A(n) ___ electrode is an electrode that does not melt and become part of the weld.

______________ **19.** Argon and helium are the shielding gases most commonly used in the ___ process.

______________ **20.** ___ is a superheated gas capable of conducting an electric arc and is typically considered the fourth state of matter because it does not have the exact properties of a solid, liquid, or gas.

Short Answer

1. What is an electrode angle?

2. List the types of filler metal transfer that can be used with the GMAW process.

3. Describe FCAW-S.

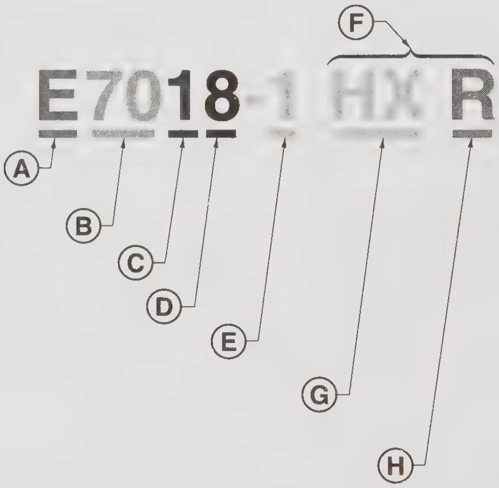
4. Explain how shielding gas is used before, during, and after GTAW operations.

5. How is PAC equipment classified?

Identification

SMAW Wire Classification

Identify the SMAW electrode wire classification system components.



______________ **1.** Additional operating characteristics

______________ **2.** Electrode

______________ **3.** Hydrogen per weld deposit

______________ **4.** Improved impact strength

______________ **5.** Meets absorbed moisture requirements

______________ **6.** Tensile strength

______________ **7.** Type of coating and current

______________ **8.** Welding position

Bead Characteristics

Identify the causes of the bead formation.

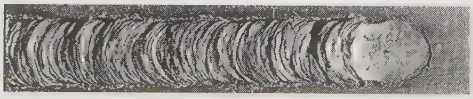
______________ **1.** Current and travel speed normal

______________ **2.** Current too high

______________ **3.** Current too low

______________ **4.** Travel speed too fast

______________ **5.** Travel speed too slow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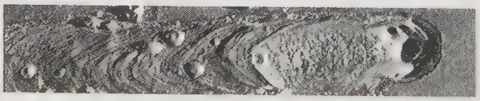
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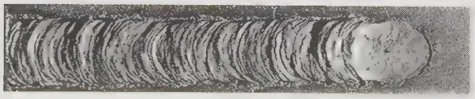
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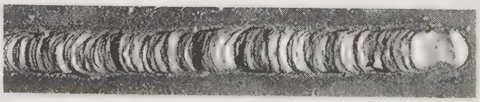
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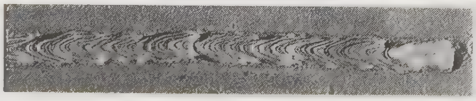
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The Lincoln Electric Company

GMAW Electrode Classification

Identify the GMAW electrode classification system components.

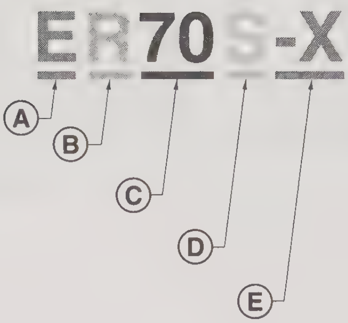
____________________ **1.** Chemical composition

____________________ **2.** Electrode

____________________ **3.** Rod

____________________ **4.** Tensile strength of deposited weld

____________________ **5.** Wire type



Effects of Shielding Gas on Penetration

Identify the shielding gas used on the penetrations.

____________________ **1.** Argon

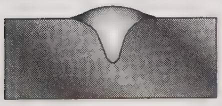
____________________ **2.** Argon-CO_2

____________________ **3.** Argon-helium

____________________ **4.** Argon-oxygen

____________________ **5.** CO_2

____________________ **6.** Helium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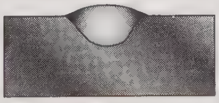
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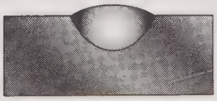
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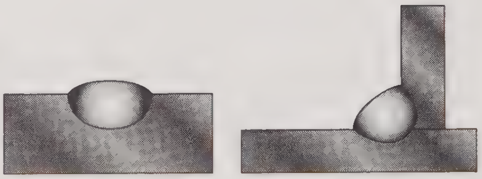
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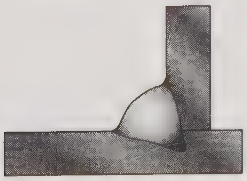
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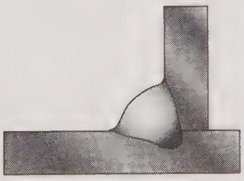
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FCAW Wire Classification

Identify the FCAW electrode wire classification system components.

____________________ **1.** Electrode

____________________ **2.** Electrode shape

____________________ **3.** Hydrogen limit

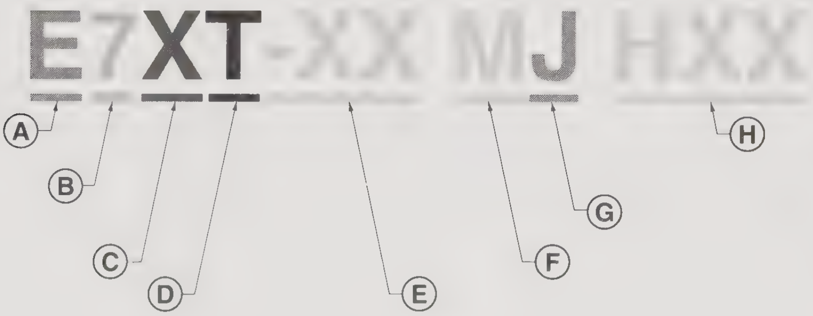
____________________ **4.** Passes improved toughness test

____________________ **5.** Gas type

____________________ **6.** Tensile strength

____________________ **7.** Usability

____________________ **8.** Welding position



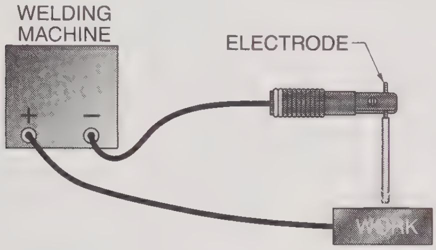
Arc Welding and Plasma Arc Cutting 24

Activities

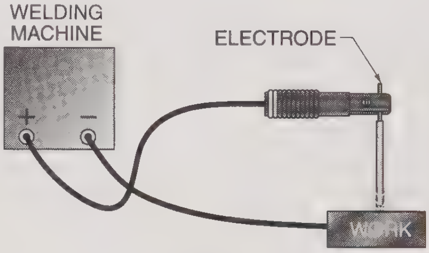
Name ______________________________ Date ____________________

Activity 24-1: SMAW

1. Use arrows to show the flow of electrons in the following circuits.


WELDING MACHINE
+
−
ELECTRODE
WORK

DCEN


WELDING MACHINE
+
−
ELECTRODE
WORK

DCEP

2. List the type of current produced by the following welding machines.

Transformer: ______________________________

Inverter: ______________________________

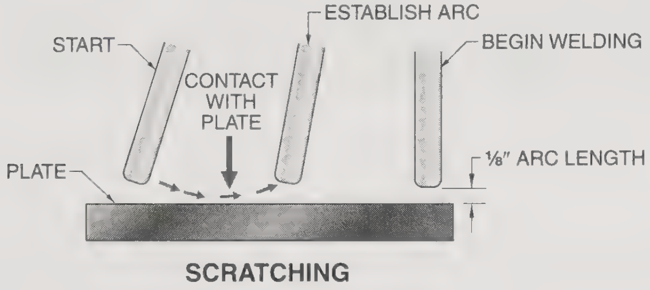
Transformer Rectifier: ______________________________

3. Supply the characteristics pertaining to the electrodes used in SMAW.

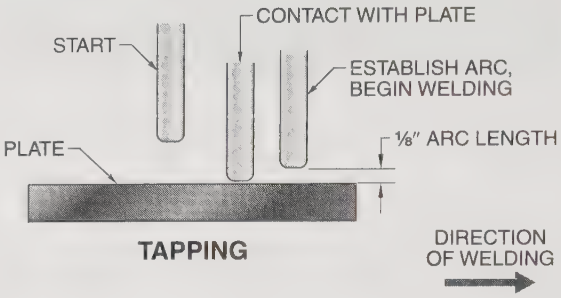
AWS Classification	Weld Current	Position
EXX10		
EXX20		
EXX11		
EXX12		
EXX13		
EXX14		
EXX24		
EXX15		
EXX16		
EXX27		
EXX18		
EXX28		

Activity 24-2: Striking the Arc in SMAW

1. Practice striking the arc in SMAW by using the scratching and/or tapping method in the desired location without excess spatter and without the electrode sticking to the plate.


START
ESTABLISH ARC
BEGIN WELDING
CONTACT WITH PLATE
PLATE
⅛″ ARC LENGTH

SCRATCHING

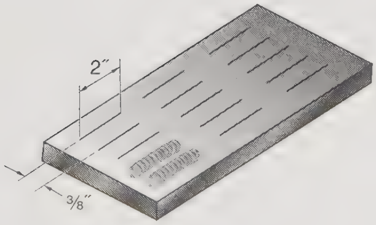

START
CONTACT WITH PLATE
ESTABLISH ARC, BEGIN WELDING
PLATE
⅛″ ARC LENGTH
DIRECTION OF WELDING

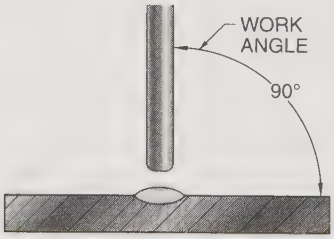
TAPPING

Note: Activity should be performed with the following conditions:
- Flat position
- DCEN
- E6012 – ⅛″
- ¼″workpiece

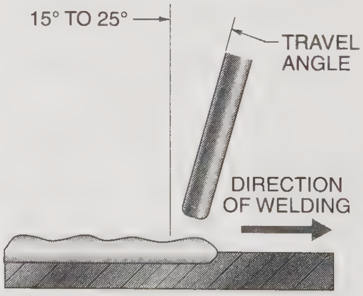
Activity 24-3: Depositing Short Beads Using SMAW

1. Practice using SMAW to deposite short beads approximately ⅜″ in width and parallel to the length of the workpiece.




WORK ANGLE
90°

END VIEW


15° TO 25°
TRAVEL ANGLE
DIRECTION OF WELDING

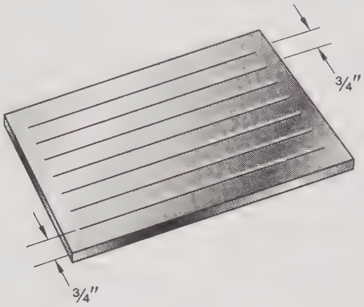
SIDE VIEW

Note: Activity should be performed with the following conditions:
- Flat position
- DCEN
- E6012 – ⅛″
- ¼″ workpiece

Activity 24-4: Depositing Continuous Beads Using SMAW

Practice depositing continuous beads consistent in width and parallel to the length of the workpiece by applying the following procedure.

1. Use a soapstone to mark a series of lines ¾″ apart.
2. Deposit beads using the lines as a guide.
3. Remove the slag and examine the beads for consistent ripple formation.



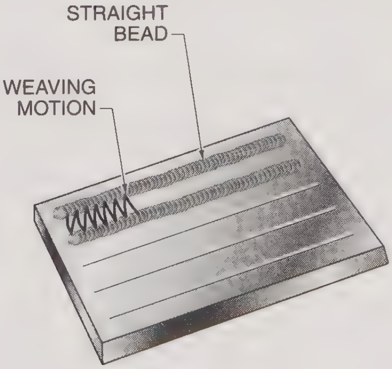
Note: Activity should be performed with the following conditions:

- Flat position
- DCEP
- E6010 – ⅛″
- ¼″ workpiece

Activity 24-5: Weaving the Electrode

Practice weaving the electrode by applying the following procedure.

1. Lay out a series of lines parallel to the length of the workpiece at 1″ intervals.
2. Deposit straight beads over the lines.
3. Use a weaving motion to deposit a bead between the straight beads on the workpiece.
4. Use a crescent, figure eight, or rotary weaving motion as necessary with the electrodes used.



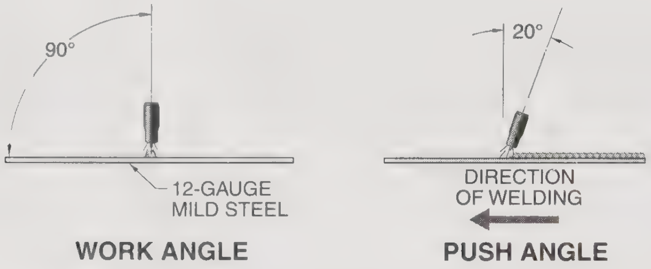
Note: Activity should be performed with the following conditions:

- Flat position
- DCEP
- E6010 – ⅛″
- ¼″ workpiece

Activity 24-6: Depositing Beads on Mild Steel in Flat Position Using GTAW without Filler Metal

Practice depositing continuous beads without filler metal approximately ⅛″ wide and parallel to the length of the workpiece by applying the following procedure.

1. To start the arc, activate the current flow by pushing the foot pedal or turning on the switch at the torch.
2. Position the torch at a 45° angle, with the electrode ⅛″ from the workpiece.
3. When the arc starts, raise the torch to a 90° work angle and a 20° push angle.
4. Maintain a short arc while depositing beads approximately ⅜″ apart. Hold the torch in position at the end of each bead until the postflow times out.



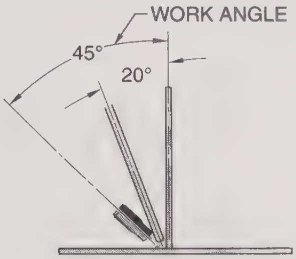
Note: Activity should be performed with the following conditions:

- Flat position
- DCEN
- 50 A to 60 A
- ³⁄₃₂″, EWTh-2, EWLa-1.5, or EWCe-2 tapered tungsten electrode with ⅛″ to ³⁄₁₆″ electrode stickout
- 100% argon shielding gas, 15 cfh to 20 cfh with 15-second postpurge
- High frequency set to start (automatic)
- 16-gauge, 4″ × 6″ mild steel

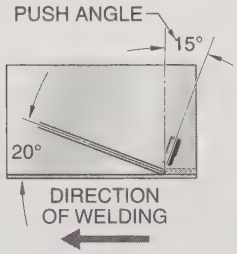
Activity 24-7: Welding a T-Joint on Mild Steel in Horizontal Position Using GTAW

Practice welding a T-joint in the horizontal position by applying the following procedure.

1. Tack weld the two pieces to form a T-joint.
2. Hold the torch at a 45° work angle and a 10° to 15° push angle.
3. Add filler metal by holding it at a 20° angle from the bottom plate and a 20° angle from the vertical plate.
4. Weave the torch slightly while adding filler metal with an in-and-out motion.
5. Maintain a consistent bead along the workpiece. Hold the torch in position at the end of the weld until the postflow times out.
6. Repeat the exercise using the lay-wire technique.
7. Repeat each exercise using pulsed current.



WORK ANGLE



PUSH ANGLE

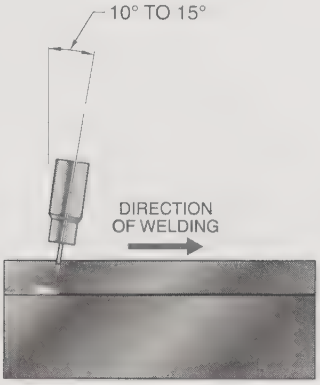
Note: Activity should be performed with the following conditions:

- Horizontal position
- DCEN
- 50 A to 60 A
- 3/32″, EWTh-2, EWLa-1.5, or EWCe-2 tapered tungsten electrode with ⅛″ to 3/16″ electrode stickout
- 100% argon shielding gas, 15 cfh to 20 cfh with 15-second postpurge
- High frequency set to start (automatic)
- Two pieces of 16-gauge, 1½″ × 6″ mild steel
- 1/16″ filler metal

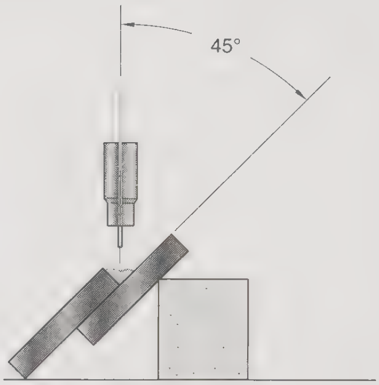
Activity 24-8: Welding a Lap Joint on Mild Steel in Flat Position Using GTAW

Practice welding a lap joint in the flat position by applying the following procedure.

1. Set the wire feeder for the correct current setting.
2. Adjust the voltage for the correct setting.
3. Tack weld the two pieces to form a lap joint.
4. Secure the tack welded workpiece in a positioner, or rest it against a firebrick to obtain the flat position.
5. Use a 45° work angle and a 10° to 15° drag angle with a slight weaving motion to deposit the bead.
6. The bead face should be flat to slightly convex.



DRAG ANGLE



WORK ANGLE

Note: Activity should be performed with the following conditions:

- Flat position
- DCEP
- 90 A to 120 A
- 17 V to 20 V
- 0.035″ diameter wire, E70S-3
- 100% CO_2 or 75% Argon/25% CO_2 shielding gas, 15 cfh to 25 cfh
- Electrode extension, ¼″ to ⅜″
- 3⁄16″–¼″ × 4″ × 6″ mild steel

Activity 24-9: Welding a Butt Joint on Mild Steel in Vertical Position Using GMAW

Practice welding a butt joint in the vertical position by applying the following procedure.

1. Set the wire feeder for the correct current setting.
2. Adjust the voltage for the correct setting.
3. Tack weld the two pieces to form a butt joint. Allow a 3⁄32″ root opening.
4. Position the workpiece so the joint is in the vertical position.
5. Start the weld at the top or bottom of the joint.
6. Use a 90° work angle and a 15° drag angle with a slight weaving motion.

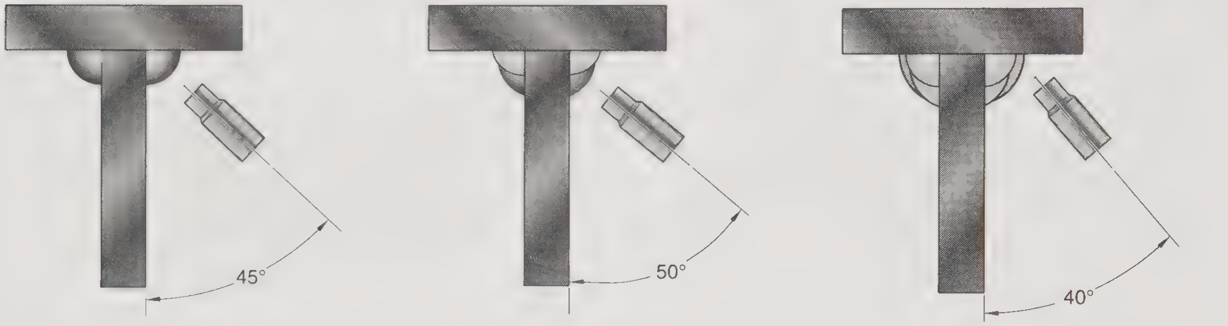
Note: Activity should be performed with the following conditions:

- Vertical position
- DCEP
- 90 A to 120 A
- 17 V to 20 V
- 0.035″ diameter wire, E70S-3
- 100% CO_2 or 75% Argon/25% CO_2 shielding gas, 15 cfh to 25 cfh
- Electrode extension, ¼″ to ⅜″
- Two pieces of ¼″ × 2″ × 4″ mild steel

Activity 24-10: Welding a Multiple-Pass T-Joint on Mild Steel in Overhead Position Using GMAW

Practice welding a multiple-pass T-joint in the overhead position by applying the following procedure.

1. Set the wire feeder for the correct current setting.
2. Adjust the voltage for the correct setting.
3. Tack weld the two pieces to form a T-joint.
4. Position the workpiece so the joint is in the overhead position.
5. Deposit the first pass using a 45° work angle and a 5° to 10° drag angle on both sides of the joint.
6. Deposit the second pass using a 50° work angle and a 5° to 10° drag angle on both sides of the joint with a slight weaving motion.
7. Deposit the third pass using a 40° work angle and a 5° to 10° drag angle on both sides of the joint with a slight weaving motion.

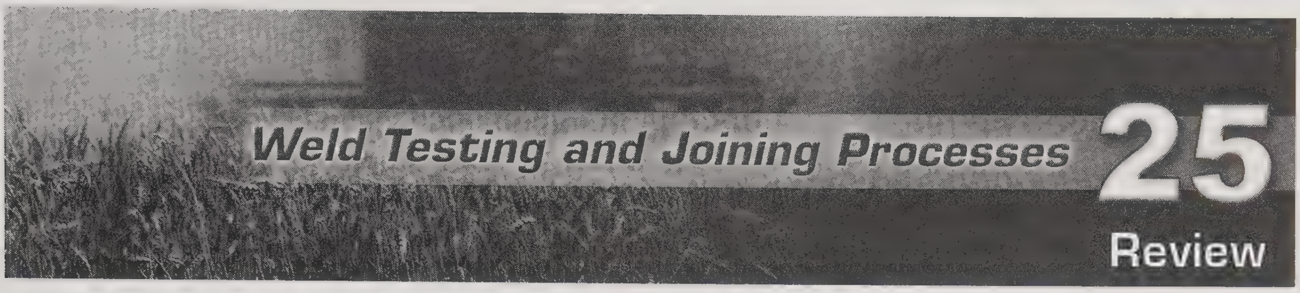


Pass 1 **Pass 2** **Pass 3**

WORK ANGLE

Note: Activity should be performed with the following conditions:

- Overhead position
- DCEP
- 90 A to 120 A
- 17 V to 20 V
- 0.035″ diameter wire, E70S-3
- 100% CO_2 or 75% Argon/25% CO_2 shielding gas, 15 cfh to 25 cfh
- Electrode extension, ¼″ to ⅜″
- Two pieces of ¼″ × 2″ × 4″ mild steel



Weld Testing and Joining Processes

25

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** Destructive testing is used to develop quality-control acceptance specifications in manufacturing and to determine if electrodes and filler metals meet the requirements of the specifications.

T F **2.** The two main types of tensile tests are the tension test and the peel test.

T F **3.** Hardness tests measure the capacity of materials to absorb energy at high strain rates (changes in dimensions because of stress) and deform plastically rather than fracture in a brittle manner.

T F **4.** Break tests are a fast and convenient method of evaluating certain types of welds for welder qualification.

T F **5.** Nondestructive examination is more convenient than destructive testing on large and costly welded units.

T F **6.** A disadvantage of using visual examination to examine a workpiece is that there is no way to detect internal defects in the weld area.

T F **7.** Radiographic examination is sensitive and is capable of locating fine surface and subsurface cracks, as well as other internal defects.

T F **8.** Ultrasonic examination is used primarily in automatic production testing of welded pipe and tube.

T F **9.** Proof testing is used to demonstrate the ability of the welded structure to carry loads equal to or greater than the expected service conditions.

T F **10.** Resistance welding is widely used in agricultural manufacturing to join sheet metal rapidly.

T F **11.** Resistance welding can be used for joining almost all steels, aluminum alloys, and some dissimilar metals.

T F **12.** Resistance spot welding is the most commonly used resistance welding process.

T F **13.** Resistance spot welding is similar to ordinary spot welding except the welds overlap, making a continuous seam.

T F **14.** The upset welding process consists of placing the projections in contact with the parts and aligning them between the electrodes.

T F **15.** A disadvantage with plastic welding is the bulge (flash) or increased size that results at the weld.

T F **16.** Projection welding is a resistance welding process that produces a weld on the mating surfaces of parts using the heat obtained from resistance to the flow of current through the surface contact areas while they are under pressure.

T F **17.** Thermosetting plastics soften only once when exposed to heat and cannot be reheated without destroying chemical properties.

T F **18.** Thermoplastics can repeatedly soften when heat is applied and harden when heat is removed.

T F **19.** If a plastic is heat-weldable, an appropriate type rod and correct temperature should be selected.

T F **20.** The types of joints used in solvent welding are the same as those used in metal welding: butt, corner, edge, lap, and T.

T F **21.** High-speed welding uses a welding gun designed to provide hot gas at the weld.

T F **22.** Underheating the weld area must be avoided because the filler material and the base material can char and discolor, resulting in a weak, unacceptable weld.

T F **23.** One-pass welding reduces welding time and decreases the chances of lack of fusion, which may occur with multiple passes of round strips.

T F **24.** The speed of making welds can be substantially increased using the high-speed welding process.

T F **25.** In high-speed welding, the weld should be checked by bending a test weld 90°.

Multiple Choice

______________ **1.** When properly applied, ___ examination is a reliable method for detecting discontinuities open to the surface of a workpiece.

A. magnetic particle
B. liquid penetrant
C. radiographic
D. ultrasonic

______________ **2.** The ___ of a material is its resistance to deformation (permanent deformation), indentation, or scratching.

A. hardness
B. toughness
C. strength
D. malleability

_______________ **3.** A ___ test is a destructive test in which a specimen is broken by a single blow and the energy absorbed in breaking it is measured in foot-pounds (ft-lb).

A. hardness
B. toughness
C. break
D. shear

_______________ **4.** A ___ test is a destructive test conducted by saw-cutting a small notch in a weld specimen, followed by breaking it with hammer blows.

A. fillet weld break
B. nick break
C. tension shear
D. peel

_______________ **5.** With heated-tool welding, a(n) ___ typically controls the heat output of the heating element.

A. capacitor
B. inductor
C. rheostat
D. thermocouple

_______________ **6.** Typical types of thermoplastics include ___.

A. epoxies
B. melamines
C. polyfluorides
D. ureas

_______________ **7.** ___ examination is a method of examination that uses X rays or gamma rays to detect internal and external discontinuities in welds.

A. Electromagnetic
B. Radiographic
C. Ultrasonic
D. Magnetic particle

_______________ **8.** ___ examination is effective in testing both ferrous and nonferrous materials for porosity, slag inclusions, internal cracks, external cracks, and lack of fusion.

A. Electromagnetic
B. Radiographic
C. Visual
D. Magnetic particle

_______________ **9.** Typical thermosetting plastics include ___.

A. polyvinyl chloride
B. polypropylene
C. polyester
D. polyethylene

______ **10.** ___ welds have three variables that affect weld quality: clamping pressure, current level, and hold time.

A. Spot
B. Seam
C. Upset
D. Flash

______ **11.** ___ welding is used to butt- or miter-weld sheet, bar, rod, tubing, and extruded sections.

A. Projection
B. Flash
C. Resistance
D. Upset

______ **12.** ___ welding is a resistance welding process that produces a weld on the mating surfaces of parts using the heat obtained from resistance to the flow of current through the surface contact areas while they are under pressure.

A. Plastic
B. Flash
C. Hot gas
D. Upset

______ **13.** ___ examination requires the use of a cleaner, a penetrant, and a developer to complete the test process.

A. Magnetic particle
B. Liquid penetrant
C. Radiographic
D. Ultrasonic

______ **14.** ___ welding is accomplished by either handfeed or high-speed welding techniques.

A. Hot gas
B. Flash
C. Upset
D. Resistance

______ **15.** ___ welding uses a stream of compressed air or inert gas directed over the heated element, which then flows out of the nozzle and onto the surface of the material being bonded.

A. Seam
B. High-speed
C. Handfeed
D. Spot

Completion

______ **1.** ___ testing involves taking sample portions of a welded structure and subjecting them to loads until they fail.

____________________ **2.** ___ force occurs when a mechanical load is applied axially to stretch the test specimen.

____________________ **3.** A(n) ___ is a device used for measuring the size and shape of a weld.

____________________ **4.** Liquid penetrant tests cannot be performed on materials with excessively ___ surfaces.

____________________ **5.** In ___ examination, a high-frequency sound beam is directed into a part on a predictable path.

____________________ **6.** ___ plastics are not weldable.

____________________ **7.** ___ examination is the use of the naked eye, assisted as necessary by low-power magnification and measuring devices, to monitor weld quality.

____________________ **8.** ___ examination uses dyes suspended in high-fluidity liquids to penetrate solid materials through capillary action and indicate the presence of discontinuities.

____________________ **9.** ___ examination uses a strong magnetic field and a fine iron powder to detect surface and near-surface discontinuity in ferrous metals.

____________________ **10.** ___ examination is a method of examination that uses ultrasonic waves to determine various attributes of a material.

____________________ **11.** ___ testing is a method of examination that uses electromagnetic energy to detect discontinuities in welds.

____________________ **12.** ___ is the application of specific loads to welded structures, without failure or permanent deformation, to assess their mechanical integrity.

____________________ **13.** ___ welding joins weld parts by passing a high electric current through them.

____________________ **14.** ___ is the time the electrodes remain in place to assist the bonding of the weld after electricity is no longer passing from one electrode to another.

____________________ **15.** ___ welding produces a weld using heat obtained from resistance between workpiece projections to the welding current.

____________________ **16.** ___ welding produces a weld at a specified location by using the heat of the arc when the parts touch and the application of pressure after heating.

____________________ **17.** ___ welding is often used to join parts in the fabrication of plastic products for agricultural applications, such as storage tanks, boxes, and other containers.

____________________ **18.** ___ welding uses a specially-designed gun containing an electric heating unit for the filler material.

____________________ **19.** In the ___ welding process, heat for welding is generated in a hot tool and transferred directly from the tip to the weld zone.

____________________ **20.** ___ welding is a welding process in which a solvent is applied that can temporarily dissolve plastic, allowing two plastic surfaces to bond to one another.

Short Answer

1. List the types of destructive tests that can be performed on welds.

2. List the advantages and disadvantages of performing a visual examination test.

3. List the five most common types of resistance welding.

4. Explain why material toughness of metals is important.

5. What is the main use of solvent welding in agriculture?

Identification

Plastic Welding Tips

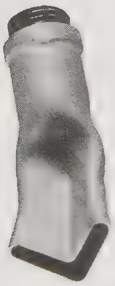
Identify the types of plastic welding tips.

______________ **1.** Flat

______________ **2.** Round

______________ **3.** Tacker

______________ **4.** V-shaped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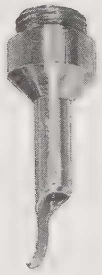
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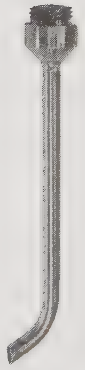
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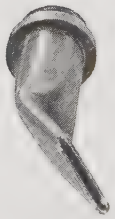
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Kamweld Technologies, Inc.

Plastic Welding Joints

Identify the types of plastic welding joints.

______________________ **1.** Double-V butt joint

______________________ **2.** Single-V butt joint

______________________ **3.** Fillet corner joint

______________________ **4.** Single-V corner joint

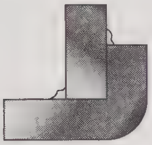
______________________ **5.** Single-V edge joint

______________________ **6.** Double-fillet lap joint

______________________ **7.** Double-bevel T-joint

______________________ **8.** Double-fillet T-joint

______________________ **9.** Single-bevel T-joint



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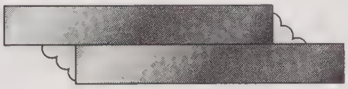

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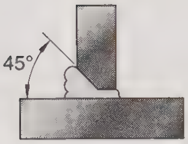

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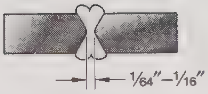

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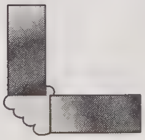

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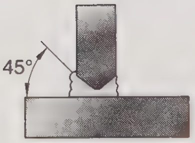

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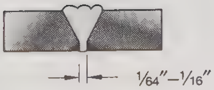

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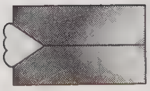

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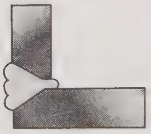

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Resistance Welding Processes

Identify the resistance welding processes.

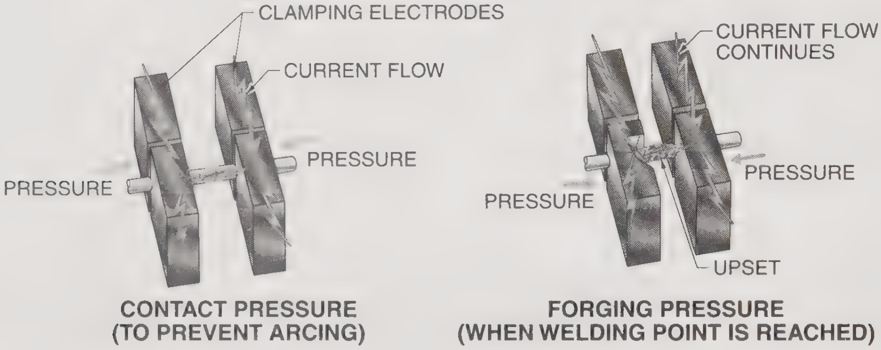
________________ **1.** Flash welding

________________ **2.** Projection welding

________________ **3.** Resistance seam welding

________________ **4.** Roller spot welding

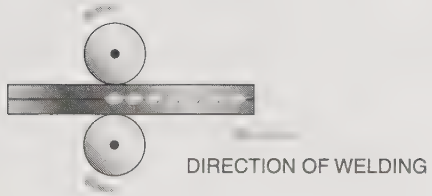
________________ **5.** Upset welding


CLAMPING ELECTRODES
CURRENT FLOW
PRESSURE
PRESSURE
CURRENT FLOW CONTINUES
PRESSURE
PRESSURE
UPSET

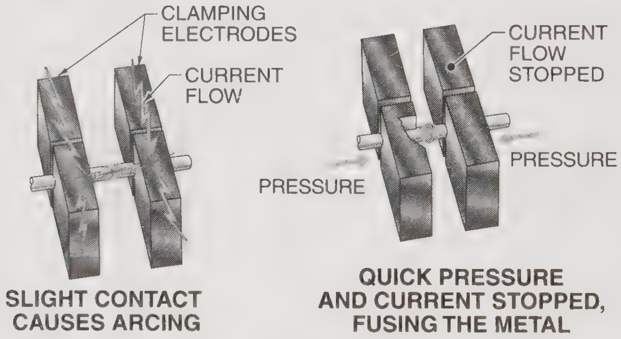
CONTACT PRESSURE (TO PREVENT ARCING)

FORGING PRESSURE (WHEN WELDING POINT IS REACHED)

Ⓐ


DIRECTION OF WELDING

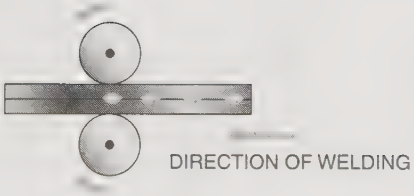
Ⓑ


CLAMPING ELECTRODES
CURRENT FLOW
CURRENT FLOW STOPPED
PRESSURE
PRESSURE

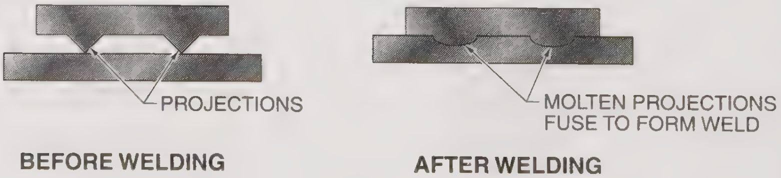
SLIGHT CONTACT CAUSES ARCING

QUICK PRESSURE AND CURRENT STOPPED, FUSING THE METAL

Ⓒ


DIRECTION OF WELDING

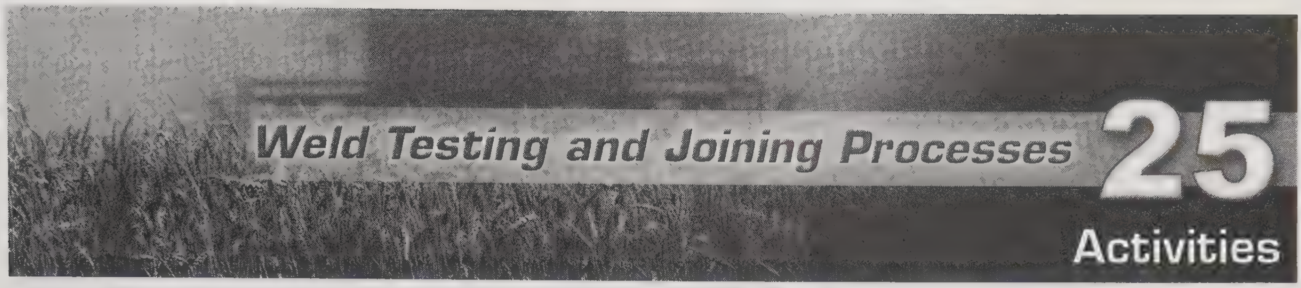
Ⓓ


PROJECTIONS
MOLTEN PROJECTIONS FUSE TO FORM WELD

BEFORE WELDING

AFTER WELDING

Ⓔ



Weld Testing and Joining Processes

25

Activities

Name ____ **Date** ________________________

Activity 25-1: Plastic Welding

Explain the following plastic welding techniques.

1. Hot Gas:

2. Heated Tool:

3. Solvent Welding:

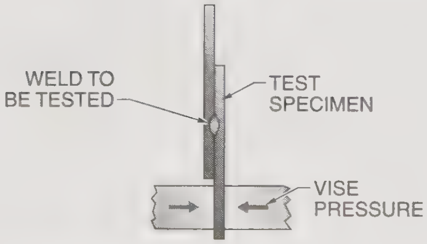
Activity 25-2: Visual Examination of Welds

1. Prepare four multiple-pass T-joints. Use the visual examination method to check for the following external weld discontinuities/defects. Mark the checklist "OK" if no defect is present. Place a check by the discontinuities/defects that are present.

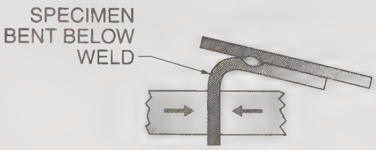
WELD DEFECTS PRESENT				
Discontinuity/Defect	**Specimen 1**	**Specimen 2**	**Specimen 3**	**Specimen 4**
Cracks				
Undercutting				
Overlapping				
Slag Inclusion				
Inadequate Penetration				
Improper Bead Size				
Improper Bead Contour				

Activity 25-3: Weld Bend Testing

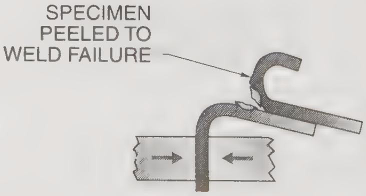
1. Prepare three lap joint specimens. Use a vise and pliers to check for the quality of fusion and degree of weld penetration.


WELD TO BE TESTED
TEST SPECIMEN
VISE PRESSURE

① SPECIMEN IS GRIPPED IN VISE


SPECIMEN BENT BELOW WELD

② SPECIMEN IS BENT AT A POINT BELOW THE WELD

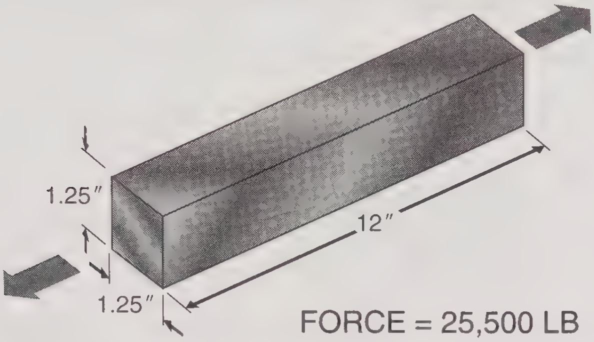

SPECIMEN PEELED TO WELD FAILURE

③ SPECIMEN IS PEELED THROUGH WELD AREA

Activity 25-4: Tensile Strength

________________ **1.** What is the tensile strength of a 25,000 lb force applied to a square steel rod with a cross-sectional area of 2.5 sq in.?

________________ **2.** Find the tensile strength of the following specimen.



Activity 25-5: Properties of Metals

Identify each metal property as physical (P), mechanical (M), or chemical (C).

________________ **1.** Chemical inhomogeneity

________________ **2.** Hardness

________________ **3.** Strength

________________ **4.** Corrosion resistance

________________ **5.** Solubility

________________ **6.** Electrical conductivity

________________ **7.** Coefficient of linear expansion

Activity 25-6: Carbon Steel Alloys

Refer to the Carbon Steel Alloy Families chart for the following questions.

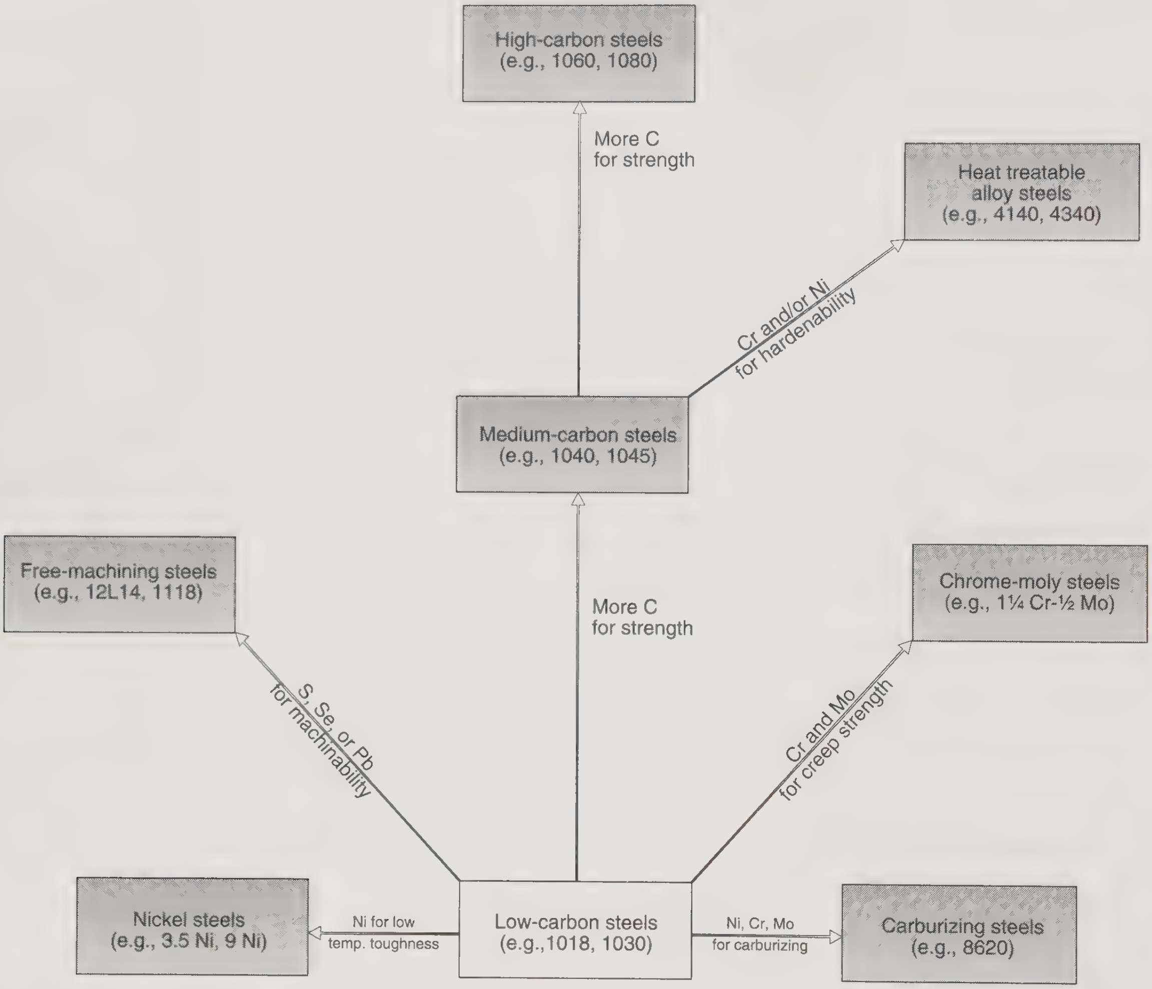
____________________ **1.** ___ is added to low-carbon steels and medium-carbon steels to increase strength.

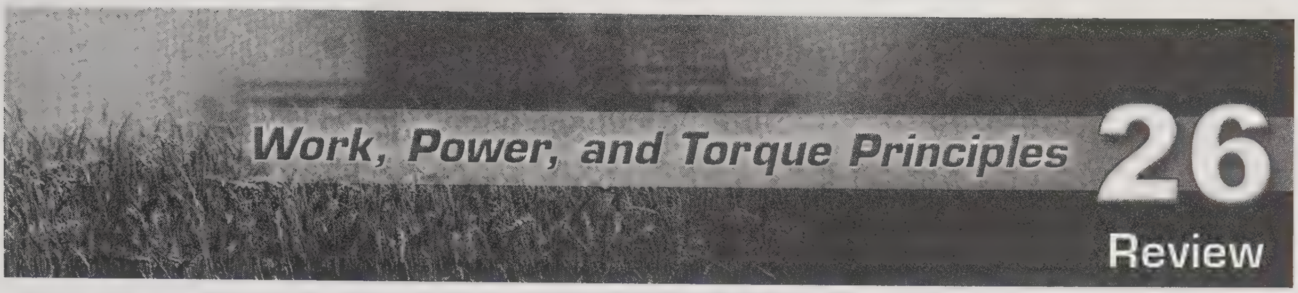
____________________ **2.** Adding nickel for low temperature toughness produces ___.

____________________ **3.** Type 4140 is a(n) ___ alloy steel.

____________________ **4.** Chrome-moly steels are produced by adding ___ and ___.

____________________ **5.** Chromium and molybdenum increase the ___ of steels.


High-carbon steels (e.g., 1060, 1080)
More C for strength
Heat treatable alloy steels (e.g., 4140, 4340)
Cr and/or Ni for hardenability
Medium-carbon steels (e.g., 1040, 1045)
Free-machining steels (e.g., 12L14, 1118)
More C for strength
Chrome-moly steels (e.g., 1¼ Cr-½ Mo)
S, Se, or Pb for machinability
Cr and Mo for creep strength
Nickel steels (e.g., 3.5 Ni, 9 Ni)
Ni for low temp. toughness
Low-carbon steels (e.g.,1018, 1030)
Ni, Cr, Mo for carburizing
Carburizing steels (e.g., 8620)



Work, Power, and Torque Principles

26

Review

Name ______________________________ Date ____________________

True-False

T F **1.** The law of conservation of energy states that energy can neither be destroyed nor created, although it can be transformed from one form of energy to another.

T F **2.** Kinetic energy is the combined forces of different forms of energy.

T F **3.** Total energy can be described as released potential energy.

T F **4.** Thermal energy is what other forms of energy turn into when the system is inefficient.

T F **5.** Pressure energy begins the moment pressure is applied at the beginning of a system.

T F **6.** Force is the resource that provides the ability to do work.

T F **7.** The operation of an internal combustion engine or electric motor is based on basic energy conversion principles.

T F **8.** Heat is transferred from one substance to another when a temperature difference exists.

T F **9.** Heat convection occurs in small engines through the medium of lubricating oil.

T F **10.** A pump housing is a multichannel container that allows air to pass around the channels to remove heat from the liquid within.

T F **11.** Radiant energy waves move through space without producing heat.

T F **12.** The temperature of matter is a comparison of the degree of hotness or coldness from one material to another, such as indoor air temperature to outdoor air temperature, on a certain scale.

T F **13.** The quantity of heat is the amount of energy needed to produce an accepted standard of physical change in matter.

T F **14.** Temperature is commonly expressed using the Fahrenheit or Celsius scale.

T F **15.** The Celsius scale uses 32°C as the freezing point of water and 100°C as the boiling point of water.

T F **16.** Work is anything that changes or tends to change the state of rest or motion of a body.

T F **17.** Force applied in different manners produces pressure, torque, or work.

T F **18.** Area is the number of unit squares equal to the volume of an object.

T F **19.** The purpose of a lever is to obtain mechanical advantage to overcome a large resistance with reduced effort.

T F **20.** A governor is the linear distance a piston travels inside a cylinder from the cylinder head end to the crankshaft end.

T F **21.** Power occurs only when the force results in motion.

T F **22.** The most common type of resistance in agricultural equipment power systems is friction.

T F **23.** Power is work divided by distance.

T F **24.** Horsepower is used to measure the energy produced by an electric motor or internal combustion engine while doing work.

T F **25.** All internal combustion engines use some form of fossil (hydrocarbon) fuel as a source of energy.

Multiple Choice

______________ **1.** ___ energy is stored energy ready to be used.
A. Total
B. Kinetic
C. Potential
D. Static

______________ **2.** ___ energy is stored energy a body has due to its position, chemical state, or mechanical condition.
A. Total
B. Kinetic
C. Potential
D. Static

______________ **3.** ___ energy is the typical energy source used to power a pump in irrigation, automotive, or fluid power systems.
A. Electrical
B. Mechanical
C. Total
D. Thermal

______________ **4.** ___ energy is energy produced and transferred using gears, pulleys, or belts.
A. Electrical
B. Mechanical
C. Sound
D. Thermal

____________________ **5.** In most agricultural power systems, ___ energy is mainly used for troubleshooting purposes.

A. pressure
B. thermal
C. sound
D. static

____________________ **6.** A temperature of 40°C is equal to ___°F.

A. 8
B. 72
C. 54.22
D. 104

____________________ **7.** ___ is heat transfer that occurs when currents circulate between warm and cool regions of a fluid.

A. Conduction
B. Convection
C. Induction
D. Radiation

____________________ **8.** A temperature of 155°F is equal to ___°C.

A. 68.33
B. 103.88
C. 123
D. 221.40

____________________ **9.** A common unit for heat measurement is the ___.

A. newton-meter (Nm)
B. foot-pound (ft-lb)
C. ohm (Ω)
D. British thermal unit (Btu)

____________________ **10.** ___ is anything that changes or tends to change the state of rest or motion of a body.

A. Force
B. Work
C. Power
D. Energy

____________________ **11.** ___ is equal to force times distance.

A. Work
B. Area
C. Torque
D. Power

____________ **12.** A ___ is the measurement on an internal combustion engine crankshaft of the distance from the centerline of the crankshaft to the centerline of the connecting rod journal (offset).
A. gear
B. lever
C. throw
D. gear ratio

____________ **13.** ___ is the resistance to movement between two mating surfaces.
A. Friction
B. Torque
C. Horsepower
D. Power

____________ **14.** ___ is the rate at which work is done.
A. Force
B. Work
C. Power
D. Energy

____________ **15.** ___ is commonly used to rate and rank the power produced by an internal combustion engine based on a finite engine speed.
A. Friction
B. Horsepower
C. Torque
D. Energy

Completion

____________ **1.** ___ is the capacity to do work.

____________ **2.** ___ energy is energy of motion.

____________ **3.** ___ energy is the addition of heat to make a particle or molecule move faster or the dissipation of heat to make a particle or molecule move slower.

____________ **4.** ___ energy is the flow of electrons (subatomic elements) from atom to atom.

____________ **5.** ___ energy is machine energy.

____________ **6.** ___ energy is the ability to do work by applying pressure to a fluid.

____________ **7.** ___ energy is transmitted vibration that can be sensed by the human ear.

____________ **8.** ___ is kinetic energy caused by atoms and molecules in motion within a substance.

____________ **9.** ___ is the transfer of thermal or electrical energy from one member to another through direct contact.

____________ **10.** ___ is heat transfer that occurs as radiant energy without a material carrier.

______________ **11.** ___ is the measurement of the degree or intensity of heat.

______________ **12.** A(n) ___ is the amount of heat energy required to change the temperature of 1 kilogram of water 1°C.

______________ **13.** A(n) ___, when referring to force, is anything with mass.

______________ **14.** ___ is the measure of force applied to a given unit of area.

______________ **15.** ___ is the measure of the force applied to a member to produce rotational motion.

______________ **16.** ___ is the ratio of the output force to the input force of a device.

______________ **17.** A(n) ___ is a simple machine that consists of a rigid bar that pivots on a fulcrum (pivot point) with both resistance and effort applied.

______________ **18.** ___ is force applied through a parallel distance causing linear motion.

______________ **19.** ___ is a unit of power equal to 746 watts (W) or 33,000 ft-lb/min (550 ft-lb/sec).

______________ **20.** The most common types of ___ used in agricultural applications include gasoline, diesel fuel, and kerosene.

Short Answer

1. List the main forms of energy and the types of energy that they are transformed into.

2. Explain the difference between conduction and convection.

3. What two units of measurement are commonly used to measure heat?

4. When using the metric system, how is work measured?

5. List the three most common types of power ratings.

Identification

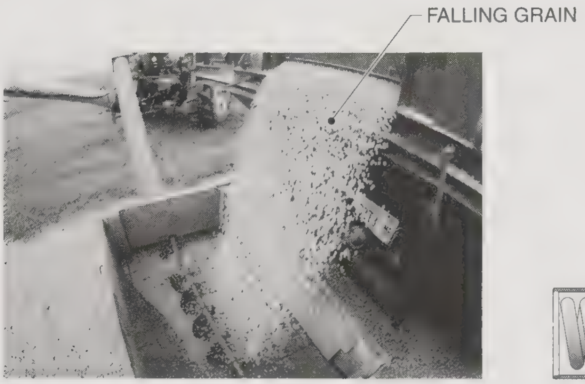
Energy Types

Identify the types of energy.

__________ **1.** Mechanical

__________ **2.** Kinetic

__________ **3.** Potential


FALLING GRAIN

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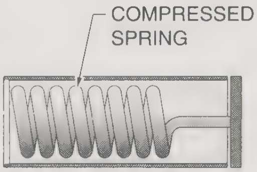
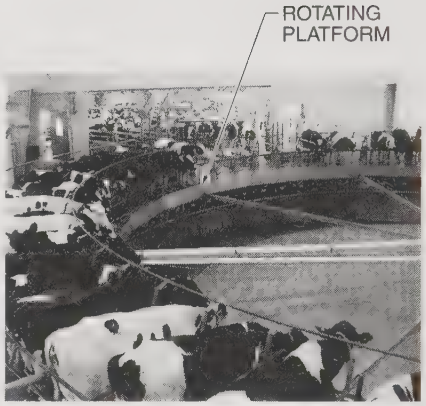

COMPRESSED SPRING

Ⓑ


ROTATING PLATFORM

Ⓒ

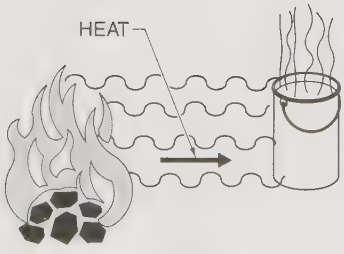
Heat Transfer

Identify the methods of heat transfer.

__________ **1.** Convection

__________ **2.** Radiation

__________ **3.** Conduction



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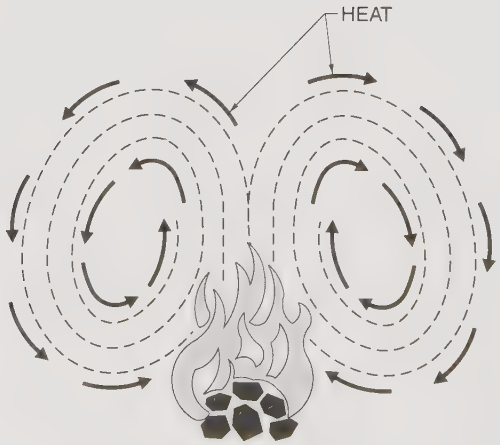

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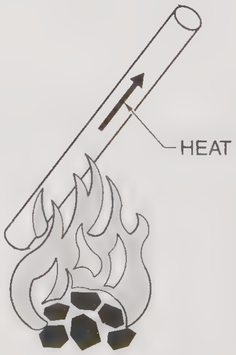

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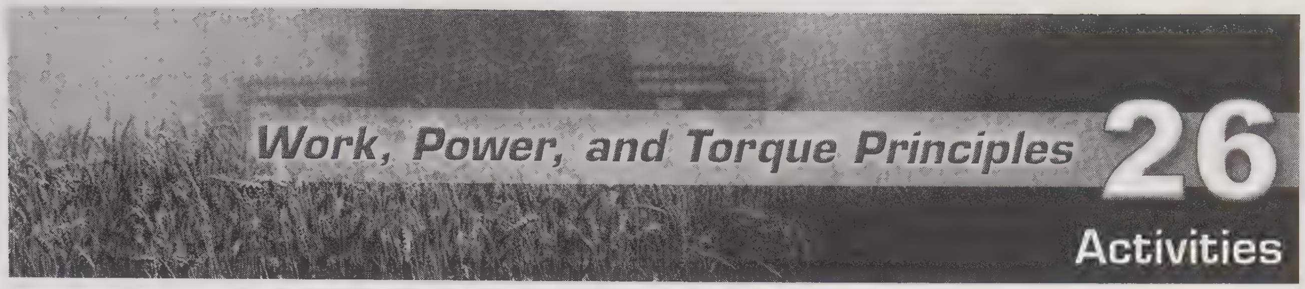


Work, Power, and Torque Principles

26

Activities

Name ______________________________ **Date** ____________________

Activity 26-1: Energy Types

1. Develop a list of all apparatus and equipment that exhibit motion on the farm and determine the type of energy that they exhibit.

Activity 26-2: Fossil Fuels

1. Develop a list of the different equipment used on a farm that is powered with an internal combustion engine and note the type of fuel required for each. Note the differences in equipment powered by diesel fuel, gasoline, kerosene, propane, and biodiesel fuel blends.

Activity 26-3: Calculations

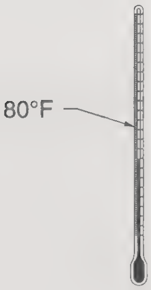
Calculate the temperature readings, converting from Fahrenheit to Celsius or from Celsius to Fahrenheit.

____________________ **1.** The temperature at A equals ___°C.

____________________ **2.** The temperature at B equals ___°C.

____________________ **3.** The temperature at C equals ___°F.

____________________ **4.** The temperature at D equals ___°F.



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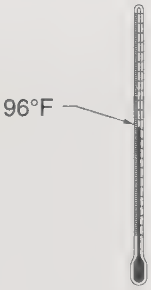

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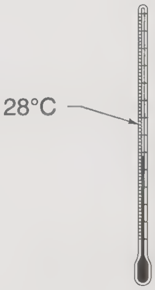

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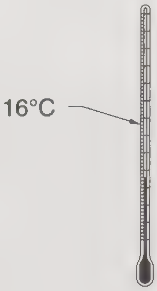


Ⓓ

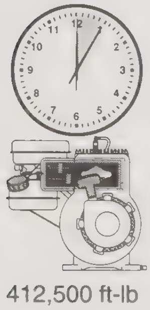
Calculate the horsepower ratings of each engine.

____________________ **5.** The horsepower rating of Engine A is ___ HP.

____________________ **6.** The horsepower rating of Engine B is ___ HP.

____________________ **7.** The horsepower rating of Engine C is ___ HP.

____________________ **8.** The horsepower rating of Engine D is ___ HP.


412,500 ft-lb

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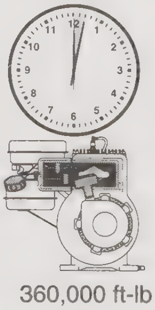
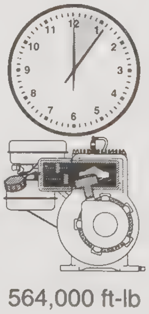

360,000 ft-lb

Ⓑ


564,000 ft-lb

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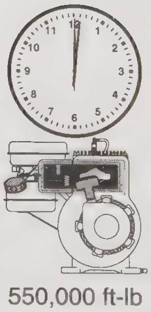

550,000 ft-lb

Ⓓ

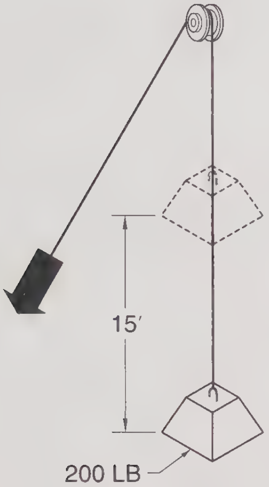
Calculate the amount of work performed.

________________ **9.** The work produced at A is ___ ft-lb.

________________ **10.** The work produced at B is ___ ft-lb.

________________ **11.** The work produced at C is ___ ft-lb.

________________ **12.** The work produced at D is ___ ft-lb.



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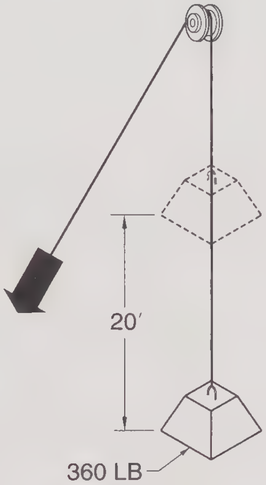

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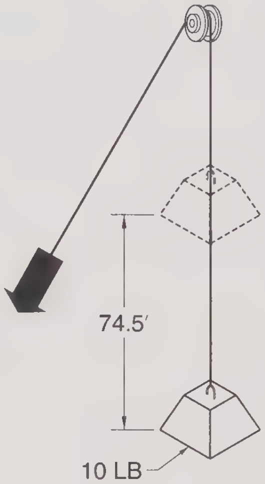

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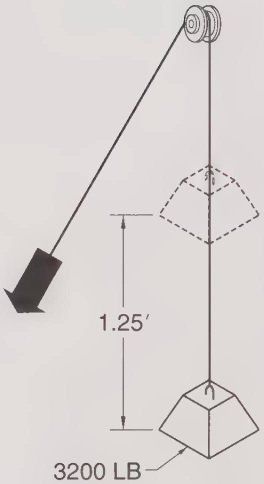

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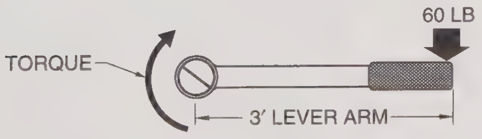
Calculate the amount of torque.

________________ **13.** The torque produced at A is ___ lb-ft.

________________ **14.** The torque produced at B is ___ lb-ft.

________________ **15.** The torque produced at C is ___ lb-ft.

________________ **16.** The torque produced at D is ___ lb-ft.


60 LB
TORQUE
3′ LEVER ARM

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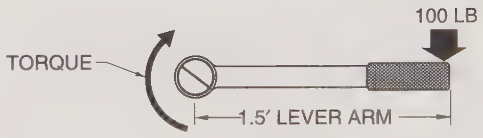
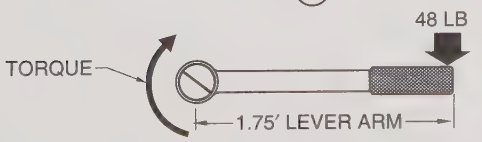

100 LB
TORQUE
1.5′ LEVER ARM

Ⓑ


48 LB
TORQUE
1.75′ LEVER ARM

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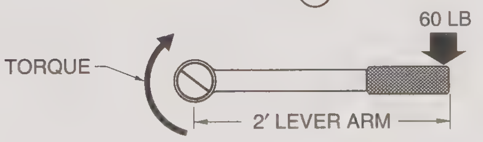
60 LB
TORQUE
2′ LEVER ARM

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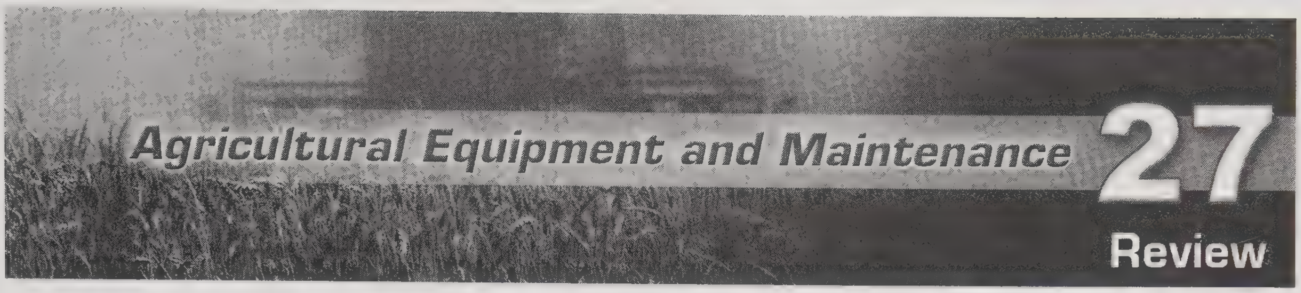


Agricultural Equipment and Maintenance

27

Review

Name ________________________________ Date ____________________

True-False

T F **1.** Wet lubricant is a lubricant in nonliquid form.

T F **2.** Bearings are classified as friction or antifriction bearings.

T F **3.** A friction bearing is a bearing that contains moving elements, which provide a low-friction support surface for rotating or sliding surfaces.

T F **4.** Oil caps are used to prevent oil from leaking out through the hole in a pump housing where the shaft protrudes.

T F **5.** A mechanical drive system is a drive system that provides a positive engagement between the drive and driven sides of the system.

T F **6.** A belt drive is a mechanical drive system that uses a belt and pulleys to transfer power between two shafts.

T F **7.** A narrow belt is a V-belt that has a smaller cross section and a higher profile than a standard belt.

T F **8.** Ladder chain is a synchronous chain that consists of a series of links joined together with bushings and pins.

T F **9.** The gear ratio determines how fast the driven gear rotates in relation to the drive gear.

T F **10.** A bevel gear is a gear with straight, tapered teeth used in applications where shaft axes intersect.

T F **11.** A cam is a machine part that transmits motion using an irregular external or internal surface.

T F **12.** Causes of belt failure include exposure to dirt particles, improper lubrication, extreme operating conditions, improper installation, and surface reaction.

T F **13.** Common causes of belt or chain failure include excessive wear, overloading, insufficient lubrication, and gear failure.

T F **14.** All hydraulic systems consist of a source, pathways, and loads.

T F **15.** A vane pump is a pump that consists of two meshing gears enclosed in a close-fitting housing.

T F **16.** Hydraulic hose and pipe fittings are used to join hydraulic lines and can be permanent or removable.

T F **17.** A directional control valve regulates the volume of hydraulic oil flowing to components in a system.

T F **18.** A hydraulic motor is a device that converts hydraulic energy into rotation.

T F **19.** Hydraulic motors are used in applications where electric motors are impractical.

T F **20.** A hydrostatic transmission is a device that transmits power hydraulically using hydraulic components.

T F **21.** The most important aspect of mechanical drive system maintenance is to prevent contamination of the hydraulic fluid.

T F **22.** A hydraulic system can handle heavy loads and generate a greater force than a pneumatic system.

T F **23.** The law of conservation of energy is the predictable relationship between the volume, pressure, and temperature of a gas.

T F **24.** An air compressor is a component that takes air from the atmosphere and compresses it to increase its pressure.

T F **25.** Air pressure may be used to pressurize small hydraulic systems.

Multiple Choice

______________ **1.** ___ is a soft metal alloy made of copper, tin, and antimony.
A. Babbitt
B. Cladding
C. Red brass
D. Copper-clad aluminum

______________ **2.** Common lubricating grease is not suitable for operating speeds over ___ rpm.
A. 3500
B. 6000
C. 10,000
D. 12,000

______________ **3.** A ___ is a machine component used to reduce friction and maintain clearance between stationary and moving parts.
A. cam
B. bearing
C. rivet
D. pulley

______________ **4.** An oil ___ is an oil reservoir located on a bearing housing to provide lubrication to a bearing.

A. tank
B. cup
C. seal
D. wick

______________ **5.** Some flat belts can operate at pulley speeds up to ___ rpm.

A. 140,000
B. 150,000
C. 160,000
D. 175,000

______________ **6.** A(n) ___ link is a chain link that is used to shorten or lengthen a chain and to connect two ends of a chain.

A. roller
B. pin
C. connecting (master)
D. offset

______________ **7.** A ___ gear is a gear with two rows of helical teeth.

A. helical
B. bevel
C. herringbone
D. spur

______________ **8.** ___ gears are typically used to provide a large speed reduction in equipment with right angle gear boxes.

A. Bevel
B. Miter
C. Worm
D. Cam

______________ **9.** In a hydraulic system, if 23,475 lb of force is produced by a piston having an area of 34 sq in., the pressure of the fluid is ___ psi.

A. 69.04
B. 690.44
C. 6904.40
D. 69,044

______________ **10.** A(n) ___ system is a fluid power system that transmits energy in an enclosed space using a liquid (hydraulic oil) under pressure.

A. pneumatic
B. plumbing
C. hydraulic
D. electrical

______________ **11.** Mobile hydraulic equipment should be inspected every ___ months if manufacturer's recommendations are not available.

A. two
B. three
C. six
D. twelve

______________ **12.** A(n) ___ is a device that controls the pressure, direction, or rate of fluid flow.

A. actuator
B. valve
C. pump
D. rod

______________ **13.** A ___ stores hydraulic fluid that is not in use in the system.

A. pump housing
B. reservoir
C. cup
D. cylinder

______________ **14.** ___ is the process of removing air that may have entered a hydraulic system.

A. Bleeding
B. Unloading
C. Transmitting
D. Pumping

______________ **15.** A(n) ___ system is a fluid power system that transmits energy using a gas (typically compressed air).

A. pneumatic
B. electro-hydraulic
C. hydraulic
D. electrical

Completion

______________ **1.** A(n) ___ is a substance that separates moving (bearing) surfaces to reduce the friction and/or wear between them.

______________ **2.** ___ may be subjected to radial loads, axial (thrust) loads, or a combination of radial and axial loads.

______________ **3.** A(n) ___ bearing contains moving elements, which provide a low-friction support surface for rotating or sliding surfaces.

______________ **4.** An oil ___ is an oil seal component that contacts the moving part of the equipment to prevent material from passing by the oil seal.

______________ **5.** A(n) ___ system is a combination of mechanical components that transfer power from one location to another.

____________________ **6.** Characteristics of ___ drives include tension, creep, and slip.

____________________ **7.** A(n) ___ belt is a flat belt containing gear teeth.

____________________ **8.** ___ chain contains roller, pin, and connecting (master) links.

____________________ **9.** ___ is the amount of movement (play) between meshing gear teeth.

____________________ **10.** A(n) ___ gear is a bevel gear used at right angles to transmit power at a 1:1 ratio.

____________________ **11.** A(n) ___ belt variable-speed drive is a mechanical drive system that uses one or two split-half adjustable pulleys and an adjusting mechanism to change output speed.

____________________ **12.** A(n) ___ is a device used to connect a mechanical drive to a prime mover.

____________________ **13.** ___ maintenance involves scheduled inspections of, adjustments to, and repairs to equipment to verify that equipment is in proper working order.

____________________ **14.** ___ law states that when a force is applied to a confined fluid, the force is felt throughout the fluid undiminished.

____________________ **15.** The ___ is a law that states energy can neither be created nor destroyed.

____________________ **16.** A(n) ___ valve is a valve that directs or prevents flow through selected passages.

____________________ **17.** A(n) ___ pump is a pump in which fluid flow is produced from pistons moving back and forth.

____________________ **18.** A(n) ___ is a flexible tube used to direct fluid under pressure.

____________________ **19.** ___ is when a pump runs against little or no pressure.

____________________ **20.** A(n) ___ is a component that converts fluid pressure into linear mechanical force.

Short Answer

1. Why are belt drives one of the most common mechanical drive systems used in agricultural applications?

2. What is a chain drive?

3. What is a gear drive?

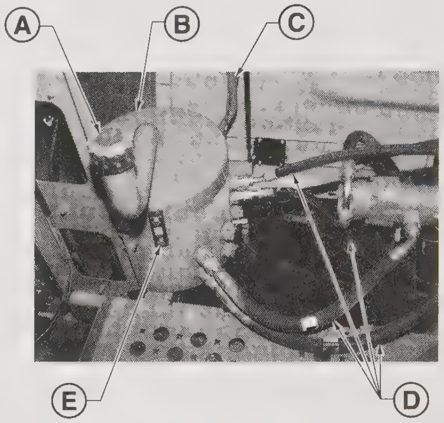
4. What is a cam used for?

5. List three common types of hydraulic valves.

Identification

Hydraulic Reservoirs

Identify the hydraulic reservoir components.



________ **1.** Suction lines

________ **2.** Return line

________ **3.** Filler cap with air vent

________ **4.** Oil level gauge

________ **5.** Reservoir

Gears

Identify the gear types.

________ **1.** Bevel

________ **2.** External spur

________ **3.** Helical

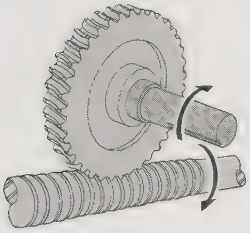
________ **4.** Herringbone

________ **5.** Internal spur

________ **6.** Miter

________ **7.** Rack and pinion spur

________ **8.** Worm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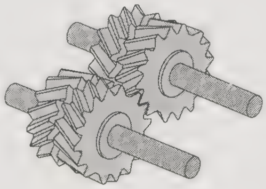
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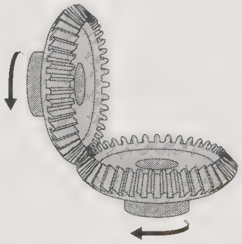
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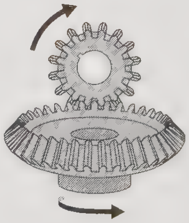
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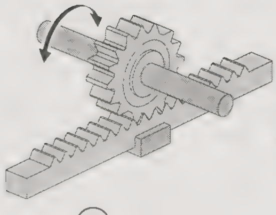
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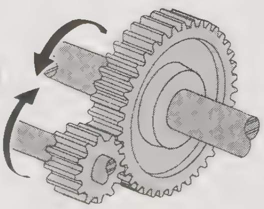
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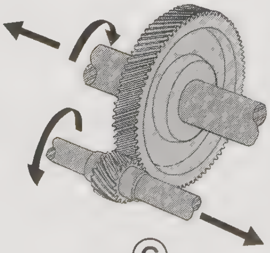
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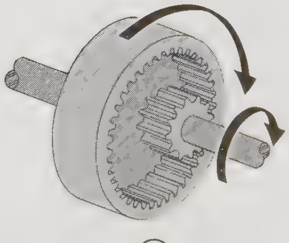
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Timing Belt Teeth

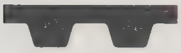
Identify the timing belt tooth profiles.

______________ **1.** Curvilinear

______________ **2.** Modified curvilinear

______________ **3.** Trapezoidal

______________ **4.** Double trapezoidal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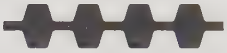
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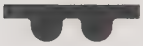
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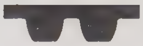
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Fluid Power Symbols — Squares or Rectangles

Refer to the Agricultural Technical Systems and Mechanics Appendix to identify the graphic symbols.

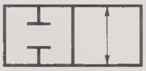
______________ **1.** Pressure switch

______________ **2.** Single-acting cylinder

______________ **3.** Double-acting cylinder

______________ **4.** Directional valve

______________ **5.** Pressure-relief valve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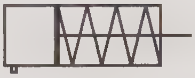
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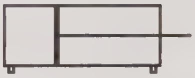
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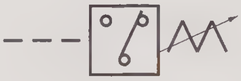
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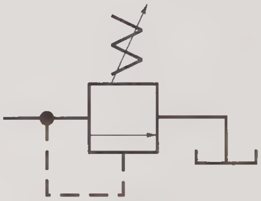
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Fluid Power Symbols — Circles

Refer to the Agricultural Technical Systems and Mechanics Appendix to identify the graphic symbols.

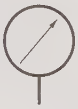
______________ **1.** Pump

______________ **2.** Motor

______________ **3.** Pressure gauge

______________ **4.** Flow meter

______________ **5.** Check valve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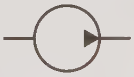
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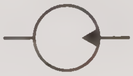
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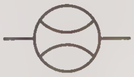
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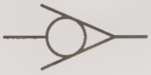
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Fluid Power Symbols — Triangles

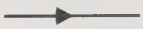
Refer to the Agricultural Technical Systems and Mechanics Appendix to identify the graphic symbols.

______________ **1.** Motor

______________ **2.** Air compressor

______________ **3.** Bidirectional motor

______________ **4.** Direction of flow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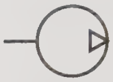
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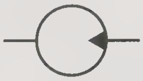
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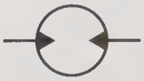
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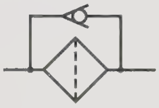
Fluid Power Symbols — Filters

Refer to the Agricultural Technical Systems and Mechanics Appendix to identify the graphic symbols.

______________ **1.** Pressure

______________ **2.** Suction

______________ **3.** Return-line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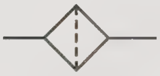
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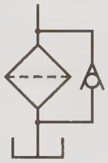
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Fluid Power Symbols — Single Actuators

Refer to the Agricultural Technical Systems and Mechanics Appendix to identify the graphic symbols.

______________ **1.** Manual

______________ **2.** Pushbutton

______________ **3.** Lever

______________ **4.** Foot pedal

______________ **5.** Solenoid

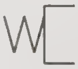
______________ **6.** Mechanical

______________ **7.** Detent

______________ **8.** Air pilot

______________ **9.** Spring

______________ **10.** Oil pilot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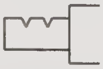
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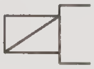
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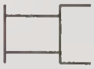
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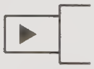
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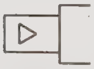
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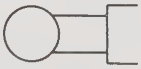
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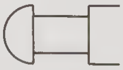
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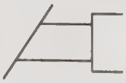
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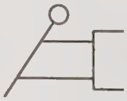
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Agricultural Equipment and Maintenance 27

Activities

Name ______________________________ Date ____________________

Activity 27-1: Hydraulic Hose Installation

Label the hydraulic hose installations as correct or incorrect.

________________ **1.** Installation A

________________ **2.** Installation B

________________ **3.** Installation C

________________ **4.** Installation D

________________ **5.** Installation E

________________ **6.** Installation F

________________ **7.** Installation G

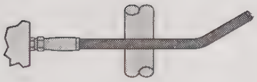
________________ **8.** Installation H

________________ **9.** Installation I

________________ **10.** Installation J

________________ **11.** Installation K

________________ **12.** Installation L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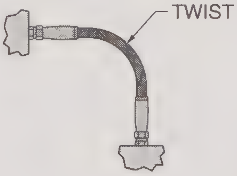

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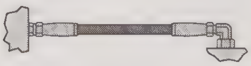
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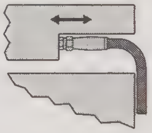
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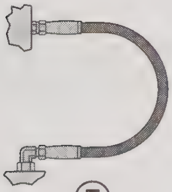
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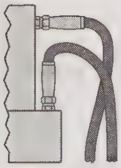
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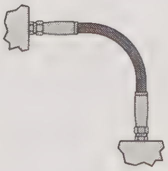
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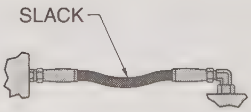

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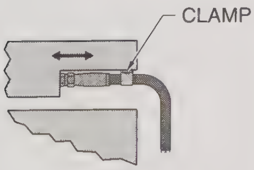

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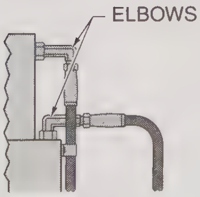

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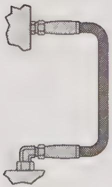
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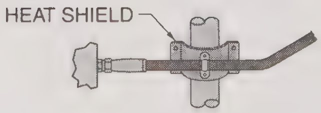

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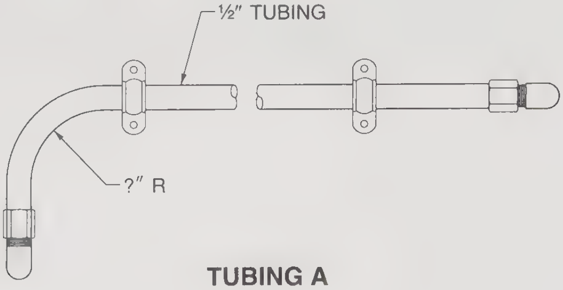
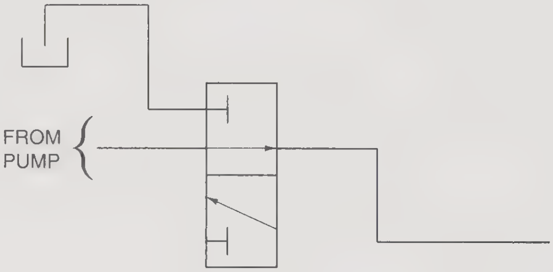
Activity 27-2: Hydraulic Applications

1. The minimum bending radius of Tubing A is ___″ R.



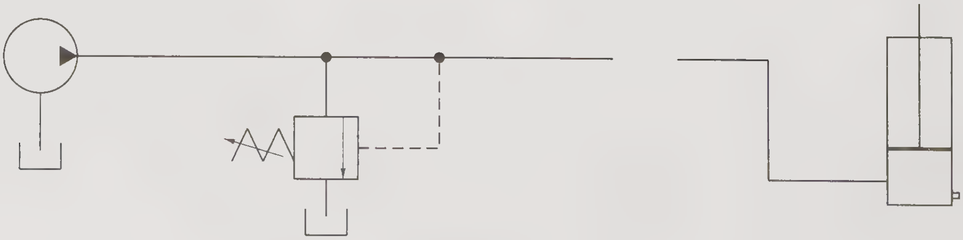
TUBING A

2. Add a single-acting spring-return cylinder to Circuit A.



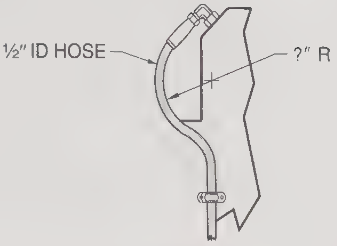
CIRCUIT A

3. Add a manually-actuated, spring-return, 3-way, two-position valve to control the cylinder in Circuit B.



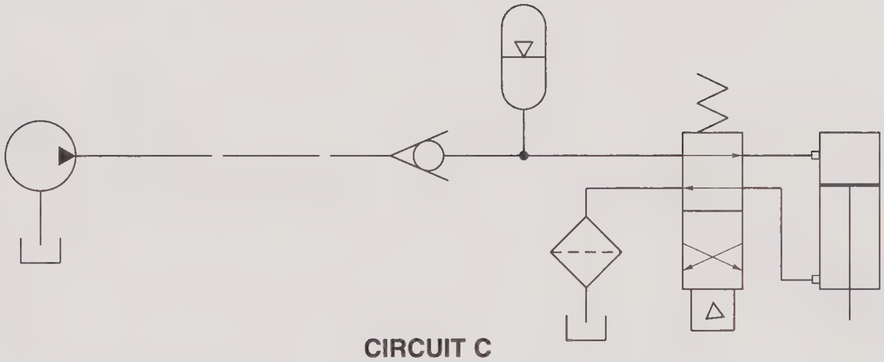
CIRCUIT B

4. The minimum bending radius of Hose A is ___″ R.



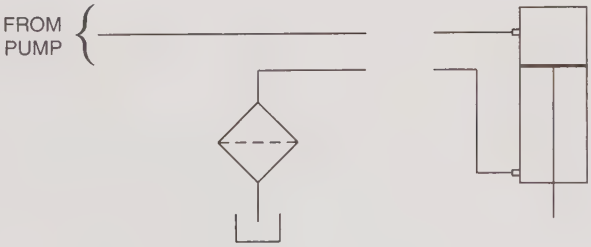
HOSE A

5. Add a pressure-relief valve to Circuit C.



CIRCUIT C

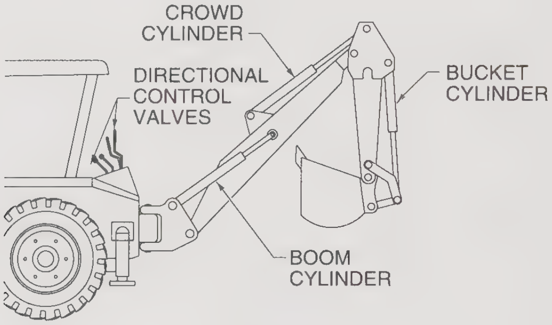
6. Add a solenoid-actuated, spring-return, 4-way, two-position directional control valve to control the fluid flow in Circuit D.

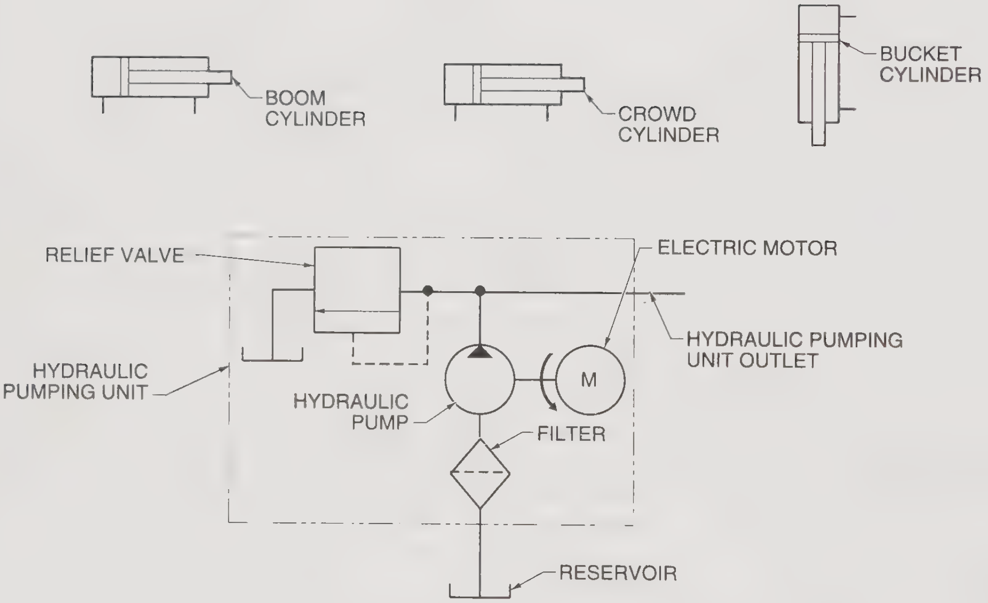


CIRCUIT D

Activity 27-3: Backhoe Application

1. Three double-acting cylinders are used to control the movement of the bucket of a backhoe. Connect each cylinder to its own maintained (detent) 3-position, lever-operated, directional control valve. The center position of each valve must block all ports, allowing each cylinder to be held in a fixed position. Include two flow control with check valves for each cylinder to control the amount of fluid (speed) flowing into each cylinder. Connect the outlet of the hydraulic pumping unit to the inlet of the valves.


CROWD CYLINDER
DIRECTIONAL CONTROL VALVES
BUCKET CYLINDER
BOOM CYLINDER


BOOM CYLINDER
CROWD CYLINDER
BUCKET CYLINDER
RELIEF VALVE
ELECTRIC MOTOR
HYDRAULIC PUMPING UNIT OUTLET
HYDRAULIC PUMPING UNIT
M
HYDRAULIC PUMP
FILTER
RESERVOIR

Activity 27-4: Recommended Pulley Diameters

Refer to the Recommended Minimum Pulley Diameters table to determine the following pulley diameters.

__________ **1.** The recommended minimum pulley diameter for a 7½ HP motor running at 160 rpm is ___″.

__________ **2.** The recommended minimum pulley diameter for a 15 HP motor running at 1750 rpm is ___ ″.

__________ **3.** The recommended minimum pulley diameter for a 1 HP motor running at 1750 rpm is ___″.

__________ **4.** The recommended minimum pulley diameter for a 100 HP motor running at 870 rpm is ___″.

RECOMMENDED MINUMUM PULLEY DIAMETERS*

Motor HP	Motor Speed†			
	870	1160	1750	3500
½	2.2	—	—	—
¾	2.4	2.2	—	—
1	2.4	2.4	2.2	—
1½	2.4	2.4	2.4	2.2
2	3.0	2.4	2.4	2.4
3	3.0	3.0	2.4	2.4
5	3.8	3.0	3.0	2.4
7½	4.4	3.8	3.0	3.0
10	4.4	4.4	3.8	3.0
15	5.2	4.4	4.4	3.8
30	6.8	6.8	5.2	—
75	10.0	10.0	8.6	—
100	12.0	10.0	8.6	—

* in in.
† in rpm

Activity 27-5: Determining Hydraulic System Inefficiencies

Refer to the Hydraulic System diagram to list the most common reason why inefficiencies could lead to an overcurrent in each of the listed component conditions.

1. The cylinder is struggling to move.

2. The pressure filter with bypass indicator is red.

3. There is a loud or unusual pump noise.

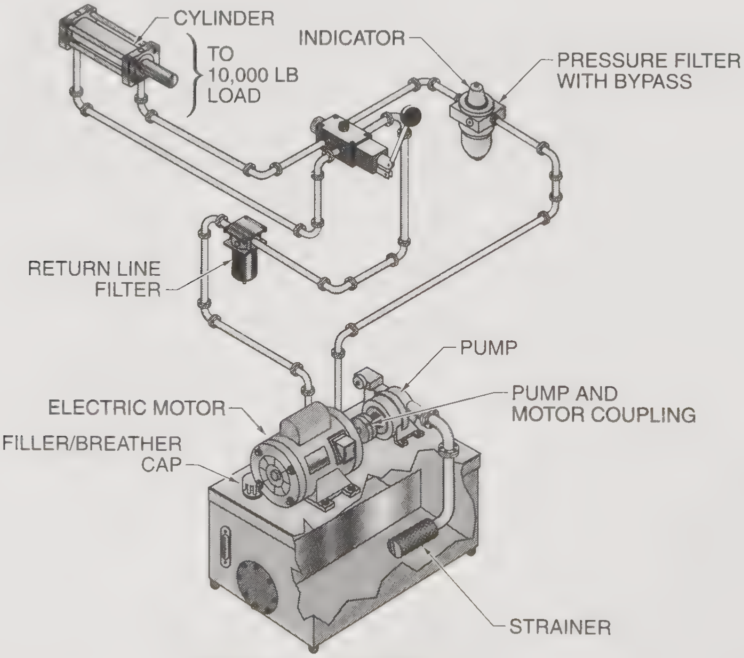
4. The pump and motor coupling is operating erratically.

5. Particles are in hydraulic fluid after it passes through the strainer.

6. Particles are in hydraulic fluid after it passes through the filler/breather cap.

7. The electric motor is running hot.

8. Particles are in hydraulic fluid after it passes through the return line filter.


CYLINDER
TO 10,000 LB LOAD
INDICATOR
PRESSURE FILTER WITH BYPASS
RETURN LINE FILTER
PUMP
PUMP AND MOTOR COUPLING
ELECTRIC MOTOR
FILLER/BREATHER CAP
STRAINER

HYDRAULIC SYSTEM

Engines and Mobile Power Equipment

28

Review

Name ____________________ Date ____________________

True-False

T F **1.** Gasoline engines can have a four- or two-stroke cycle.

T F **2.** Both four-stroke cycle and two-stroke cycle engines complete five distinct events during each cycle.

T F **3.** The five events of four-stroke cycle diesel engine operation include intake, compression, ignition, power, and exhaust for one cycle to be completed.

T F **4.** Small engines typically contain one or two cylinders but can have as many as four cylinders.

T F **5.** A cooling fan is an engine component that relieves crankcase pressure created by the reciprocating motion of the piston during engine operation.

T F **6.** A crankpin journal is a precision ground surface within which the crankshaft rotates.

T F **7.** The bearing supplies the inertia needed to prevent loss of engine speed and possible stoppage of crankshaft rotation between combustion intervals.

T F **8.** Four-stroke cycle engines control the flow of gases in the cylinder with valves.

T F **9.** A pushrod is an engine component that transfers motion from the tappet to one side of the rocker arm in overhead valve engines.

T F **10.** A three-port valving system is a two-stroke cycle engine system that uses a rotating flat disk with a section removed to control air-fuel mixture flow.

T F **11.** Coolant is commonly used in liquid-cooled engines and is circulated throughout the engine cylinder block and other engine components.

T F **12.** The components of a diesel engine are similar to the components of a gasoline engine.

T F **13.** Turbochargers are installed on some liquid-cooled multiple-cylinder engines as one method of increasing engine output without changing engine dimensions or application size limitations.

T F **14.** A flywheel is a component that provides a turbocharger with the needed rotational force to compress ambient air to a positive pressure.

T F **15.** Biodiesel fuel is simple to use, biodegradable, toxic, and contains sulfur and aromatics.

T F **16.** A cetane number is the measure of how easily diesel fuel will ignite.

T F **17.** Preventive maintenance is a group of tasks completed at specific intervals to prevent breakdowns and production inefficiency.

T F **18.** Two ingredients necessary for operation of an engine are air and fuel.

T F **19.** Air-cooled cooling system maintenance consists of periodic inspections of the integrity of the liquid coolant and components such as the radiator and hoses.

T F **20.** In order to properly maintain engine oil and extend the life of an engine, the oil and filters must be changed regularly.

T F **21.** A starter is an engine component that provides the required air-fuel mixture to the combustion chamber based on engine operating speed and load.

T F **22.** Troubleshooting is the systematic elimination of various parts of a system or processes to locate a defective or malfunctioning component.

T F **23.** One of the more common designs of centrifugal clutches uses a two-piece drive surface (shoe) pivoting on a center hub, a single return spring, a needle bearing, and an outer driven shell.

T F **24.** Electromagnetic clutches used in most agricultural power equipment applications commonly consist of five main components: a tightly wound and sealed coil of copper wire (coil), two ball bearing assemblies, a two-piece outer bracket, a clutch drive plate, and a driven plate that is attached to a V-shaped pulley.

T F **25.** Turbo speed is the time period between when the engine operator demands more power and the time when the intake air reaches maximum pressure for the desired power.

Multiple Choice

______________ **1.** With gasoline engines, approximately ___% of energy released from the gasoline is converted into work.

A. 30
B. 50
C. 75
D. 90

______________ **2.** A(n) ___ stroke is the stroke of an internal combustion engine in which heat energy produced by an explosive charge is converted to mechanical energy.

A. power
B. exhaust
C. compression
D. intake

_______________ **3.** Mixing antifreeze with water at a ratio of 50:50 lowers the freezing temperature in the engine from 32°F to about ___°F.
A. 0
B. −21
C. −34
D. −48

_______________ **4.** A ___ is an engine component that converts linear (reciprocating) motion of a piston into rotary motion.
A. pump
B. valve
C. flywheel
D. crankshaft

_______________ **5.** A ___ is a cast iron, aluminum, or zinc disk that is mounted at one end of a crankshaft to provide inertia for an engine.
A. clutch
B. valve head
C. flywheel
D. wastegate

_______________ **6.** The valve ___ is the machined surface of a valve that mates with the valve seat to seal the combustion chamber.
A. face
B. head
C. stem
D. neck

_______________ **7.** A(n) ___ is an engine component that consists of a cylinder bore, cooling fins, and valve train components, depending on engine design.
A. crankcase
B. cylinder block
C. cylinder head
D. engine block

_______________ **8.** A ___ is a diesel engine component that functions as an ON/OFF valve to introduce fuel into the cylinder.
A. fuel injector
B. fuel injection pump
C. swirl combustion chamber
D. water pump

_______________ **9.** A(n) ___ is a diesel engine component that improves engine performance through the introduction of additional air into the intake system in order to improve the volumetric efficiency of the engine.
A. injector
B. turbocharger
C. carburetor
D. wastegate

______________ **10.** A ___ is a component that takes in air and pressurizes it to a value above ambient atmospheric pressure.
- A. turbocharger compressor wheel
- B. turbocharger compressor housing
- C. turbine
- D. turbine housing

______________ **11.** A ___ is a component that acts as a bypass or pressure-relief valve within a turbocharger.
- A. compressor
- B. throttle plate
- C. wastegate
- D. vane meter

______________ **12.** The most common grade of diesel fuel used in the United States is Grade No. ___.
- A. 1-D
- B. 2-D
- C. 3-D
- D. 4-D

______________ **13.** A ___ is a component that provides drive wheel traction with independent drive wheel rotation rates, allowing power equipment with wheels to easily turn corners.
- A. clutch
- B. differential
- C. crankcase
- D. pinion gear

______________ **14.** A ___ is a drive system device that provides a smooth engagement of a mechanical drive at a specified engine rpm.
- A. centrifugal clutch
- B. differential
- C. release bearing
- D. side gear

______________ **15.** A ___ is an engine component that rides on the camshaft and pushes the bottom of the valve stem to open the valve.
- A. cam lobe
- B. rocker arm
- C. tappet
- D. valve guide

Completion

______________ **1.** A(n) ___ is a machine that converts a form of energy into mechanical force.

______________ **2.** A(n) ___ engine is an internal combustion engine that utilizes two distinct piston strokes (intake/compression and power/exhaust) to complete one operating cycle.

______________ **3.** A(n) ___ is an engine component that houses and supports the crankshaft.

______________ **4.** A(n) ___ is a cast aluminum alloy or cast iron engine component that seals the upper end of the cylinder.

______________ **5.** A(n) ___ is an engine component that transfers motion from the piston to the crankshaft and functions as a lever arm.

______________ **6.** A(n) ___ system is the system on an internal combustion engine that controls the flow of gases into and out of the combustion chamber.

______________ **7.** A(n) ___ engine is an engine that has valves and related components located within the cylinder heads and above the combustion chambers and drives the valves in a more direct manner compared to OHV and L-head engines.

______________ **8.** A(n) ___ engine circulates coolant through cavities in the cylinder block and cylinder head to maintain the desired engine temperature.

______________ **9.** A(n) ___ pump is an engine component that moves coolant through passages of a liquid cooling system.

______________ **10.** A(n) ___ pump is a diesel engine component that provides pressurized fuel to the cylinder at precise intervals.

______________ **11.** A(n) ___ is a diesel engine component that preheats air inside the combustion chamber to facilitate ignition of the charge.

______________ **12.** ___ is the process of using a compressor to increase the pressure and the density of the air entering an engine.

______________ **13.** ___ is the amount of air pressure above ambient air pressure produced by the turbocharger.

______________ **14.** ___ fuel is a clean-burning alternative fuel produced from domestic, renewable resources.

______________ **15.** A(n) ___ is a list of the maintenance tasks and frequency of when the tasks should be performed.

______________ **16.** A(n) ___ is a component that fits into the cylinder head in an internal combustion engine, isolates the electricity induced in the secondary windings, and directs a high-voltage charge to the spark gap at the tip of the spark plug.

______________ **17.** A(n) ___ is the failure of a system, equipment, or component to operate as designed.

______________ **18.** A(n) ___ is a device in the power train of a motorized vehicle that provides different gear ratios between the engine and drive wheels as well as neutral and reverse positions.

______________ **19.** A(n) ___ clutch is a flexible drive system component that uses electrical energy to create a positive belt drive engagement for an implement or attachment.

______________ **20.** A(n) ___ is a machine element used to apply force to a moving surface for the purpose of slowing or stopping in a controlled manner.

Short Answer

1. What is a small engine as it relates to mobile power equipment?

2. What are the three primary functions of a valving system?

3. Describe how diesel exhaust fluid (DEF) is used with diesel power equipment.

4. List the components specific to diesel engine operation.

5. What is a troubleshooting chart used for when working on mobile power equipment?

Identification

Diesel Engines

Identify the diesel engine components.

______________ **1.** Piston

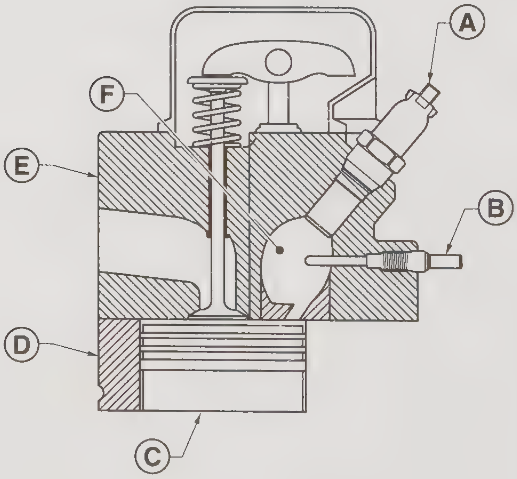
______________ **2.** Precombustion chamber

______________ **3.** Cylinder head

______________ **4.** Cylinder block

______________ **5.** Injector

______________ **6.** Glow plug



Connecting Rods

Identify the connecting rod components.

______________ **1.** Piston pin

______________ **2.** Rod cap

______________ **3.** Connecting rod

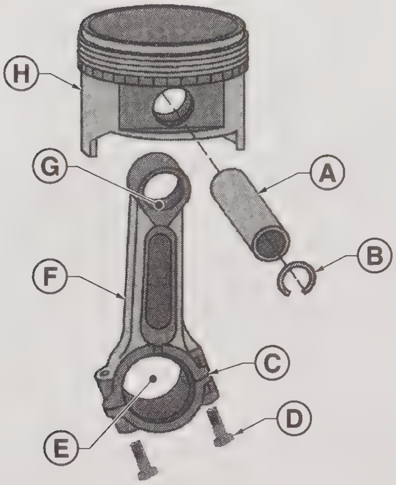
______________ **4.** Piston

______________ **5.** Piston pin bearing surface

______________ **6.** Spring clip

______________ **7.** Rod cap screw

______________ **8.** Crankpin journal bearing surface



Crankshafts

Identify the crankshaft components. Note: Components may be identified more than once.

______________ **1.** Bearing journal

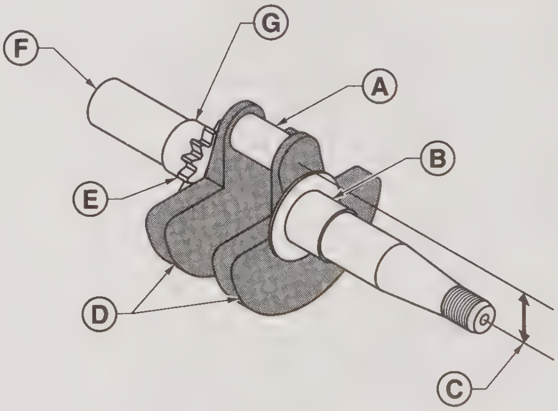
______________ **2.** Crankpin journal

______________ **3.** Crankgear

______________ **4.** PTO

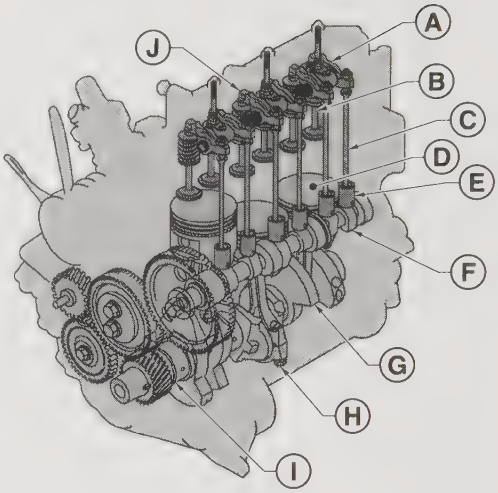
______________ **5.** Counterweights

______________ **6.** Throw



Compression Systems

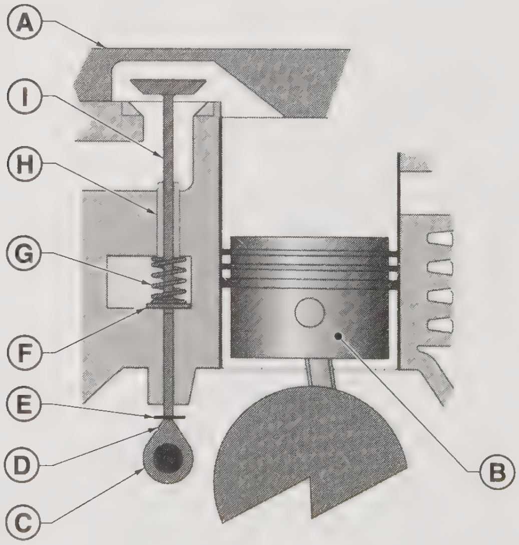
Identify the compression system components.



1. Valve train
2. Rocker arm
3. Crankshaft
4. Camshaft
5. Lifter
6. Piston
7. Valve
8. Counterweight
9. Connecting rod
10. Pushrod

L-Head Valve Systems

Identify the L-head valve system components.



1. Cam lobe
2. Camshaft
3. Cylinder head
4. Piston
5. Tappet
6. Valve guide
7. Valve retainer
8. Valve spring
9. Valve stem

OHV Systems

Identify the OHV system components.

__________ **1.** Cam lobe

__________ **2.** Cylinder head

__________ **3.** Piston

__________ **4.** Pushrod

__________ **5.** Rocker arm shaft

__________ **6.** Rocker arm

__________ **7.** Tappet

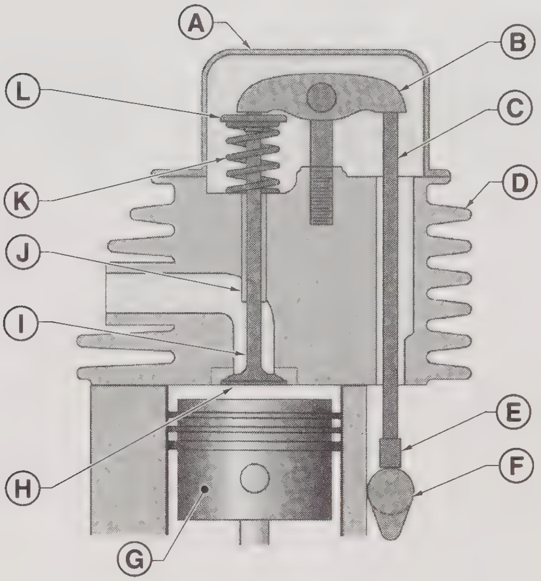
__________ **8.** Valve guide

__________ **9.** Valve head

__________ **10.** Valve retainer

__________ **11.** Valve spring

__________ **12.** Valve stem



DOV Systems

Identify the DOV system components.

__________ **1.** Cam gear

__________ **2.** Cam lobe

__________ **3.** Crankgear

__________ **4.** Lever arm

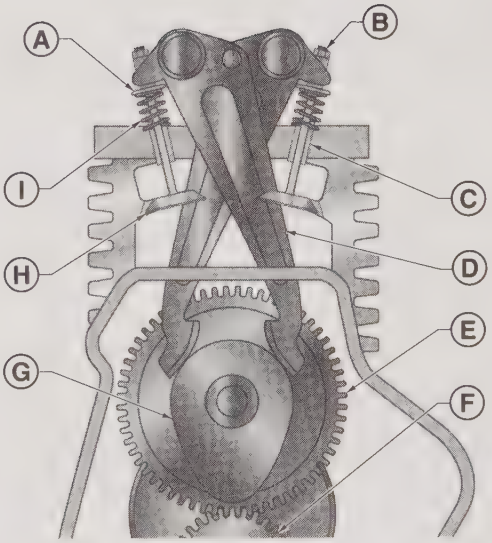
__________ **5.** Valve clearance adjuster

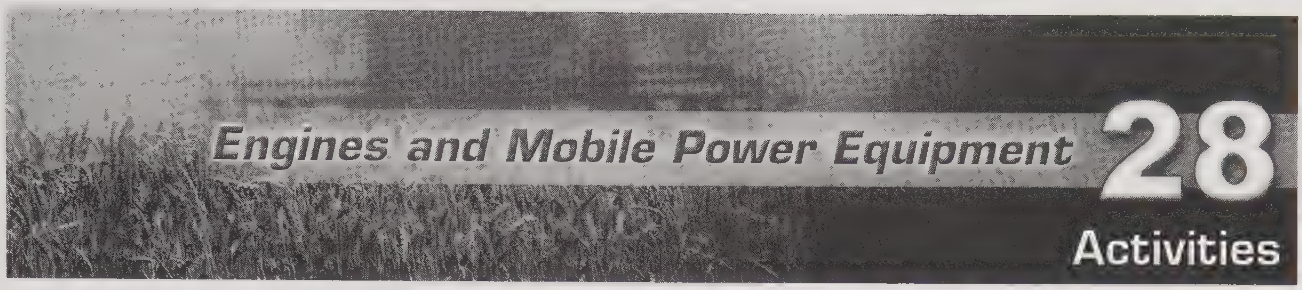
__________ **6.** Valve guide

__________ **7.** Valve head

__________ **8.** Valve retainers

__________ **9.** Valve spring





Engines and Mobile Power Equipment

28

Activities

Name ______________________________ Date ____________________

Activity 28-1: Engine Horsepower vs. Engine Torque

1. An agricultural mechanic complains that the 16 HP, 52″ commercial walk-behind rotary lawn mower in use does not move through high grass fast enough. The mechanic asks that a higher horsepower engine be installed so that the grass can be cut at a faster rate. Mechanic A says installing a 20 HP engine would solve the problem. Mechanic B says this will not increase the cutting rate of the mower because more torque is required, not horsepower. Which mechanic is correct?

Activity 28-2: Equipment Storage

1. Take an inventory of all implements and attachments in the classroom, workshop, or farm. Develop a long-term storage procedure for each seasonal implement or attachment.

Activity 28-3: Flexible Belt Inspection

1. Identify all pieces of mobile power equipment in the classroom, workshop, or farm that are belt-driven or have belt-driven implements and attachments. Inspect each flexible belt for cracks, breaks, and/or frayed sections. Use the owner's/operator's manuals to develop a list of part numbers for the belts that must be replaced.

Activity 28-4: Maintenance Service Intervals

List the maintenance tasks that must be performed on mobile power equipment for the following service intervals.

1. 50 hours

2. 100 hours

3. 400 hours

4. 600 hours

5. One year

6. 1200 hours

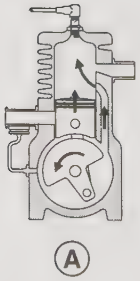
7. Two years or 2000 hours

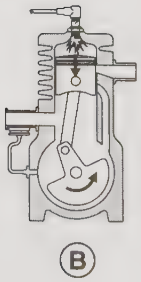
Activity 28-5: Engine Strokes

Identify the strokes of a two-stroke engine.

__________________ **1.** The stroke shown at A is the ___ stroke.

__________________ **2.** The stroke shown at B is the ___ stroke.





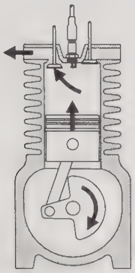
Identify the strokes of a four-stroke engine.

__________ **3.** The stroke shown at A is the ___ stroke.

__________ **4.** The stroke shown at B is the ___ stroke.

__________ **5.** The stroke shown at C is the ___ stroke.

__________ **6.** The stroke shown at D is the ___ stroke.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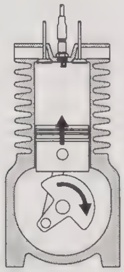
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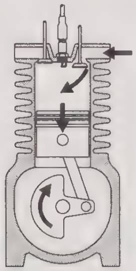
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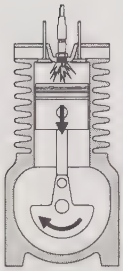
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Activity 28-6: Cylinder Designs

Identify the cylinder designs.

__________ **1.** The cylinder design at A is ___.

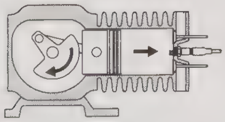
__________ **2.** The cylinder design at B is ___.

__________ **3.** The cylinder design at C is ___.

__________ **4.** The cylinder design at D is ___.

__________ **5.** The cylinder design at E is ___.

__________ **6.** The cylinder design at F is ___.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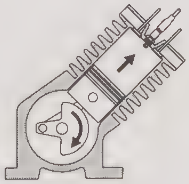
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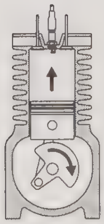
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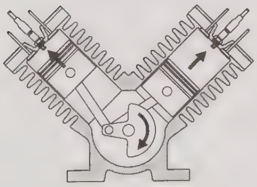
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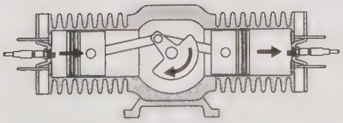
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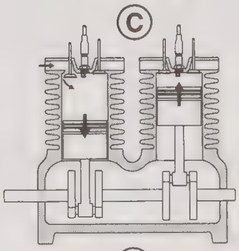
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Activity 28-7: Displacement

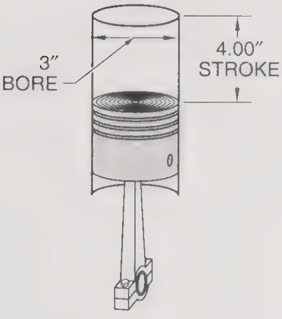
Determine the displacement of the single cylinder engines.

_______________ **1.** The displacement of the single cylinder engine at A is ___ cu in.

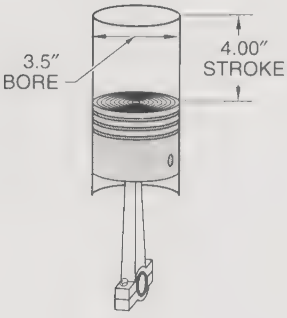
_______________ **2.** The displacement of the single cylinder engine at B is ___ cu in.

_______________ **3.** The displacement of the single cylinder engine at C is ___ cu in.

_______________ **4.** The displacement of the single cylinder engine at D is ___ cu in.


3″
BORE
4.00″
STROKE

Ⓐ


3.5″
BORE
4.00″
STROKE

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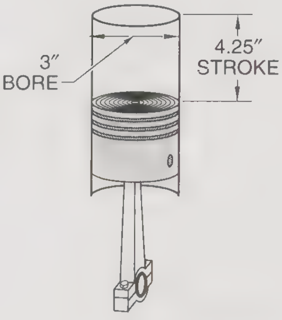
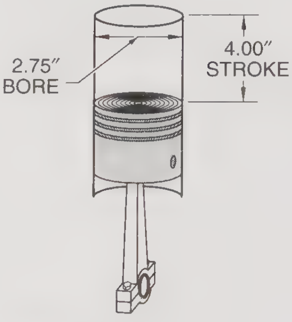

3″
BORE
4.25″
STROKE

Ⓒ


2.75″
BORE
4.00″
STROKE

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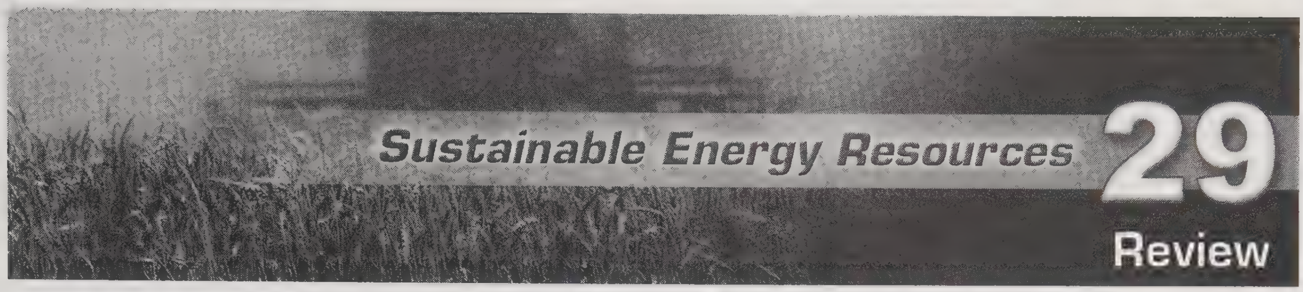


Sustainable Energy Resources

29

Review

Name ______________________________ **Date** ____________________

True-False

T F **1.** A nonrenewable resource is an energy resource that is replaceable by natural processes within a span of time.

T F **2.** Currently, the major sources of energy consumed in the United States are petroleum, natural gas, coal, renewable resources, and nuclear power.

T F **3.** A generator can absorb heat from inside a building (providing a cooling effect), or it can absorb heat from outside the building (providing a heating effect).

T F **4.** The primary components of a geothermal heat pump system are the heat pump, heat sink, heat exchanger(s), reversing valve, compressor, and expansion valve.

T F **5.** A geothermal piping system is typically filled with chemically treated water or, in cold climates, a water and antifreeze mixture.

T F **6.** The heat pump sequences of operation are similar for heating or cooling.

T F **7.** Solar energy is more accurately described as kinetic energy transformed into mechanical energy, which is used to generate electrical power.

T F **8.** Wind turbines are feasible in all locations.

T F **9.** The primary types of wind energy systems are grid-connected and stand-alone systems.

T F **10.** A stand-alone (off-grid) system is a system where the end user is capable of producing electricity from the wind turbine system and also receives electricity from a utility power provider.

T F **11.** A grid-connected wind energy system is a wind energy system that is not connected to an electric utility distribution system.

T F **12.** A wind turbine system always has three rotor blades.

T F **13.** A rotor is the central rotating shaft of a wind turbine that includes the blades and hub.

T F **14.** A synchronous generator is an AC generator that rotates at a constant speed.

T F **15.** A transformer is an electric device that uses electromagnetism to change voltage and current from one level to another.

T F **16.** The hub is the main structural device that holds the wind turbine rotor, nacelle, and other elevated devices securely in place.

T F **17.** Wind energy is energy recovered from the sun in the form of sunlight.

T F **18.** Electricity produced by a photovoltaic (PV) system that is not used immediately is stored in batteries.

T F **19.** The most common types of stand-alone PV systems are direct-coupled or self-regulating.

T F **20.** Because biomass is difficult to transport, store, and use, it is sometimes densified into different forms to make these processes less difficult.

T F **21.** An organic material is a material that is not derived from a plant or animal source.

T F **22.** Liquefaction is a thermochemical process used to produce a liquid or gaseous fuel out of solid organic waste.

T F **23.** A second type of process for converting biomass to a sustainable energy form is the biochemical (fermentation) process.

T F **24.** Densified biomass fuel (DBF) pellets are formed when loose biomass is fed though a hopper into a single-screw extruder that is similar in design to a plastics processing extruder.

T F **25.** Hybrid energy systems can be created by combining energy source systems, such as wind and solar.

Multiple Choice

________________ **1.** Depending on the geographic latitude, the temperature of the ground remains relatively constant at a distance of ___′ to ___′ below grade level.

A. 1; 2
B. 2; 3
C. 4; 5
D. 6; 8

________________ **2.** According to the U.S. ___, the demand for energy can be categorized into transportation, industrial, residential/ commercial, and electrical power.

A. Department of Energy
B. Energy Information Administration
C. Department of Agriculture, NRCS
D. Green Building Council

______________ **3.** A ___ is a housing in a wind energy system that includes the gearbox, generator, power converter, electrical controls, brakes, and other devices required to convert rotating mechanical force into electricity.

A. nacelle
B. tower assembly
C. turbine
D. yaw assembly

______________ **4.** A typical PV cell produces about ___ V of electricity.

A. 0.5
B. 1
C. 1.5
D. 2

______________ **5.** For wind power systems to be feasible, wind speed must average between ___ mph and ___ mph.

A. 6; 8
B. 8; 18
C. 20; 30
D. 30; 35

______________ **6.** Residue from the agricultural and food processing industry includes ___.

A. barley straw
B. manure
C. rice hulls
D. sugar cane stalks

______________ **7.** A ___ is a device that converts mechanical energy into electrical energy by means of electromagnetic induction.

A. generator
B. motor
C. compressor
D. wind turbine

______________ **8.** A ___ is an electronic device that changes AC voltage to DC voltage.

A. generator
B. converter
C. step-down transformer
D. relay

______________ **9.** In wind energy systems, ___ provide space and support to allow the generated power to be brought down to ground level.

A. hubs
B. towers
C. rotors
D. converters

______________ **10.** Waste from the agricultural and food processing industry includes ___.
   A. corn stalks
   B. sugarcane bagasse
   C. fruit pits
   D. oat straw

______________ **11.** Residue from the forestry industry includes ___.
   A. paper pulp
   B. forest slash
   C. scrap lumber
   D. wood shavings

______________ **12.** ___ is a fuel consisting of wood products, vegetation, and refuse.
   A. Ethanol
   B. Petroleum
   C. Biomass fuel
   D. Diesel fuel

______________ **13.** Wind energy systems that produce up to ___ are typically used by homeowners, farmers, and ranchers.
   A. 50 kW
   B. 100 kW
   C. 1 MW
   D. 5 MW

______________ **14.** ___ is the anaerobic processing of organic feed materials that occurs without oxygen and produces alcohols and organic chemicals.
   A. Gasification
   B. Liquefaction
   C. Anaerobic digestion
   D. Fermentation

______________ **15.** A(n) ___ is a type of heat exchanger that adds heat to low-pressure refrigerant liquid.
   A. compressor
   B. condenser
   C. evaporator
   D. heat pump

Completion

______________ **1.** A(n) ___ energy resource is any resource that is considered renewable, such as wind or water.

______________ **2.** ___ energy is an energy source that is derived from underground sources of water that are heated to high temperatures.

____________________ **3.** A(n) ___ system is a system that uses the temperature of the ground or water from a lake or ocean to produce temperature changes that can be used for heating or cooling applications.

____________________ **4.** A(n) ___ is a device that transfers heat between two fluids that are physically separated.

____________________ **5.** A(n) ___ is a machine that converts the kinetic energy of wind into rotating mechanical energy.

____________________ **6.** A(n) ___ wind energy system is a wind energy system that is connected to an electric utility distribution system (grid).

____________________ **7.** ___ wind energy systems usually provide power to a single residence, structure, or compound.

____________________ **8.** A(n) ___ is the center part of a wind turbine rotor to which the blades are attached.

____________________ **9.** The two main types of AC generators used in wind turbines are asynchronous generators and ___ generators.

____________________ **10.** A(n) ___ generator, or induction generator, is an AC generator that rotates at a changing speed slightly below synchronous speed.

____________________ **11.** A(n) ___ is a central electronic control device in a wind turbine that receives signals based on operating conditions.

____________________ **12.** ___ are used in wind energy systems to reduce the generator AC output voltage to the low voltage level required by many of the system control and monitoring devices.

____________________ **13.** A(n) ___ is an instrument that measures wind speed.

____________________ **14.** A(n) ___ system is a renewable energy system that collects and stores energy from the sun and is used to heat air and water in a building structure.

____________________ **15.** ___ is solar energy technology that uses the unique properties of semiconductors to convert solar radiation directly into electricity.

____________________ **16.** A(n) ___ is a PV power-generating unit consisting of a specific number of individual electrically and mechanically integrated modules with structural supports, trackers, or other devices.

____________________ **17.** A(n) ___ system is an electrical system consisting of a PV array and other electrical components needed to convert solar energy into usable electricity.

____________________ **18.** A(n) ___ PV system is a type of stand-alone PV system that uses no active control systems to protect the battery, except through careful design and device sizing.

____________________ **19.** ___ is a high-temperature process for producing gaseous fuels in the presence of an oxidant (air).

____________________ **20.** ___ is a solid combustible by-product resulting from biomass processing.

Short Answer

1. List three advantages of wind energy.

2. In wind turbine systems, what is yaw control?

3. How can solar energy be used in agriculture?

4. What is a direct-coupled PV system?

5. What is pyrolysis?

Identification

Densified Biomass Fuel (DBF) Forms

Identify the DBF forms.

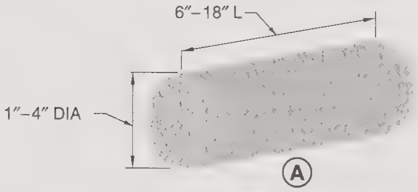
____________________ **1.** Briquettes

____________________ **2.** Cubes

____________________ **3.** Extruded cylinders

____________________ **4.** Pellets

____________________ **5.** Rolled/compressed cylinders



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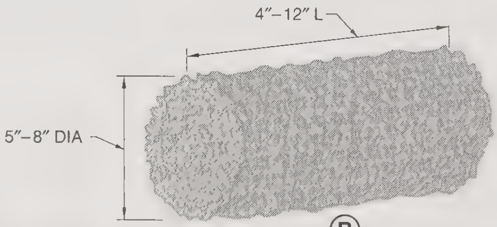

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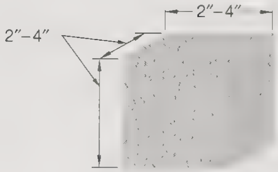

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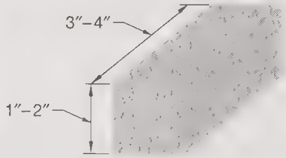

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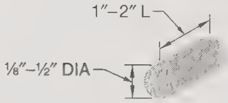

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Wind Turbine Systems

Identify the wind turbine system components.

______________ **1.** Anemometer

______________ **2.** Brake

______________ **3.** Gearbox

______________ **4.** Generator

______________ **5.** Hub

______________ **6.** Nacelle

______________ **7.** Power converter/controller

______________ **8.** Rotor blades

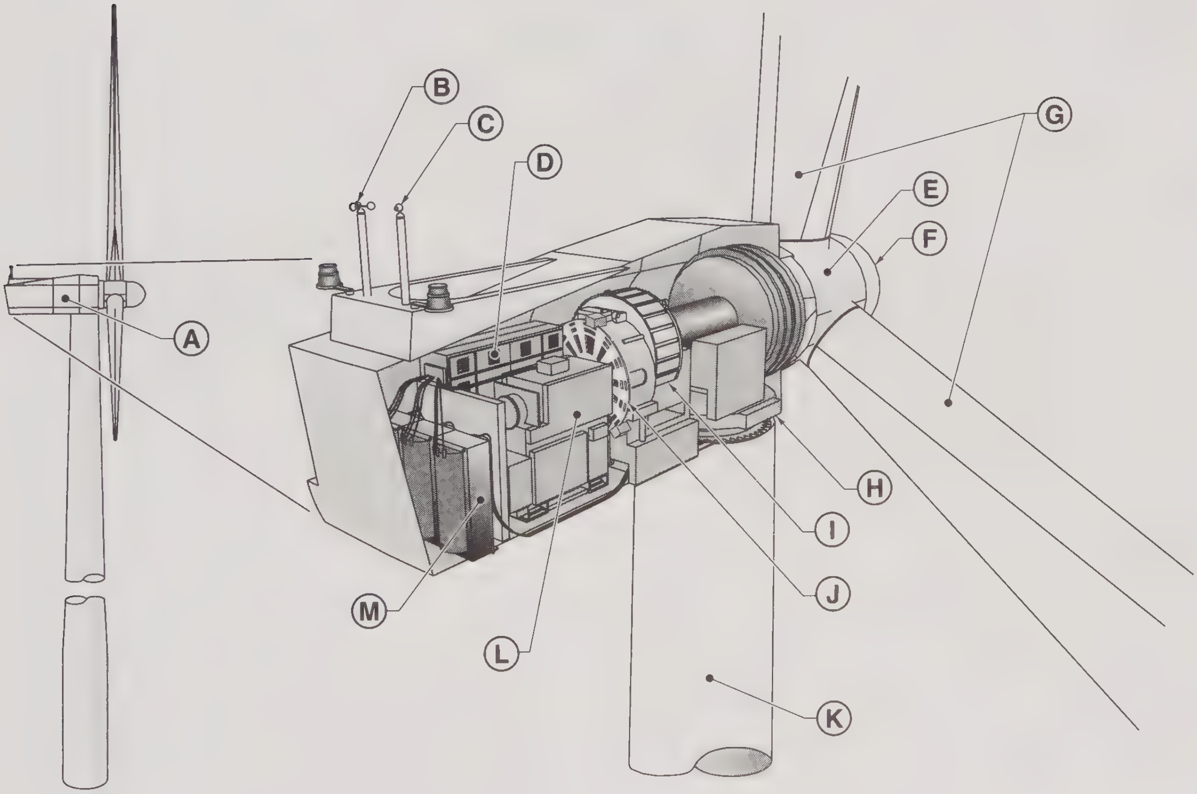
______________ **9.** Rotor

______________ **10.** Tower

______________ **11.** Transformer bank

______________ **12.** Wind vane

______________ **13.** Yaw assembly



Wind Turbine Brakes

Identify the wind turbine brake components.

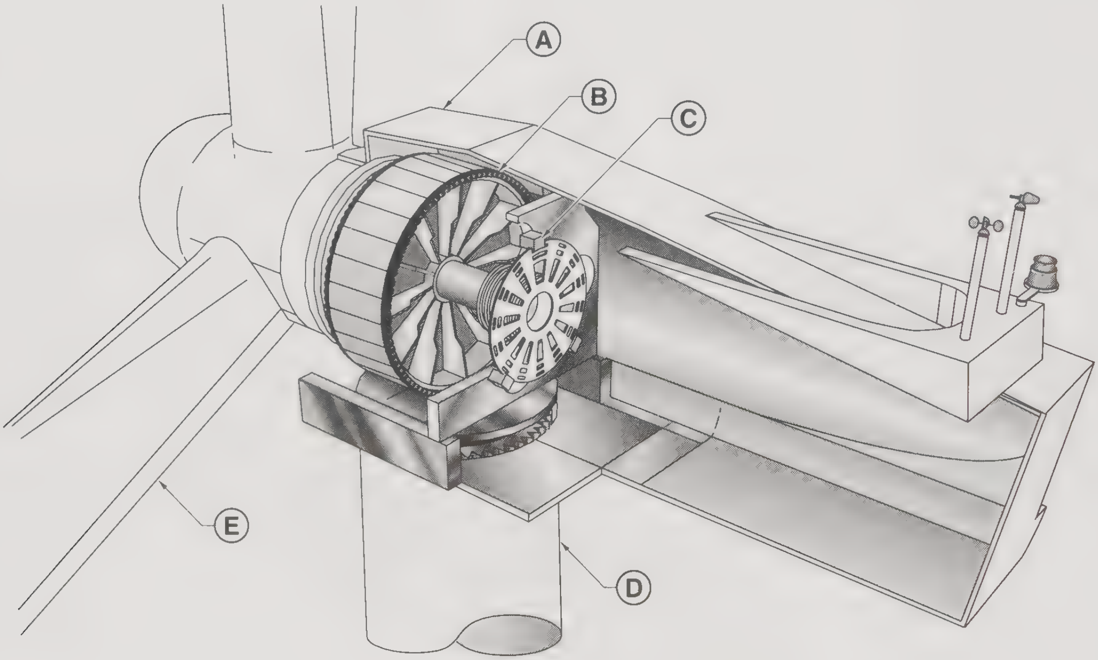
______________ **1.** Rotor

______________ **2.** Rotor blade

______________ **3.** Tower

______________ **4.** Wind turbine

______________ **5.** Wind turbine brake



Sustainable Energy Resources 29

Activities

Name ______________________________ Date ________________

Activity 29-1: Wind Turbine Power Output

The amount of power required for a residence depends on the size of the residence and the amount of power consumed. A residential power panel is sized for the maximum power usage (200 A service). However, only a fraction of the available power is used. Thus, when utilities determine the amount of generated power required, they factor in the total number of residences and their average size.

Wind farms normally supply power to the utility grid. Wind farms/wind turbines relate their total power output to the number of residences they can supply with power. Often, a power average of 3333 W per residence is used. This accounts for the fact that, at any given time, some residences use more power than others and some use less power than others.

Complete the chart by listing the approximate number of residences each wind turbine could supply with power. Round each answer to the next lowest whole number.

WIND TURBINE SIZE AND POWER RATINGS

Rotor*	Diameter†	Approximate Generator Output	Approximate Number of Homes Serviced
0.82	0.25	50 W	
7.87	2.4	900 W (0.9 kW)	
13.45	4.1	2 kW	
41	12.5	50 kW	
59	18	100 kW	
88.5	27	225 kW	
108	33	300 kW	
131	40	500 kW	
144	44	600 kW	
157	48	750 kW	
177	54	1 MW (1000 kW)	
209	64	1.5 MW	
236	72	2 MW	
262	80	2.5 MW	
328	100	3 MW	

* in ft
† in m

Activity 29-2: Energy Sources

1. List as many different energy sources as possible and determine if they are renewable or nonrenewable.

2. List as many applications for renewable energy as possible.

3. List applications for renewable energy in agriculture, such as farms, greenhouses, and irrigation.

Activity 29-3: Matter Identification

Identify the types of matter as either organic or inorganic.

____________________ **1.** Metal shavings

____________________ **2.** Algae

____________________ **3.** Quarry rock

____________________ **4.** Sewage

____________________ **5.** Pressure-treated wood

____________________ **6.** Tree bark

____________________ **7.** Water-based paint

____________________ **8.** Diamonds

____________________ **9.** Seaweed

____________________ **10.** Manure

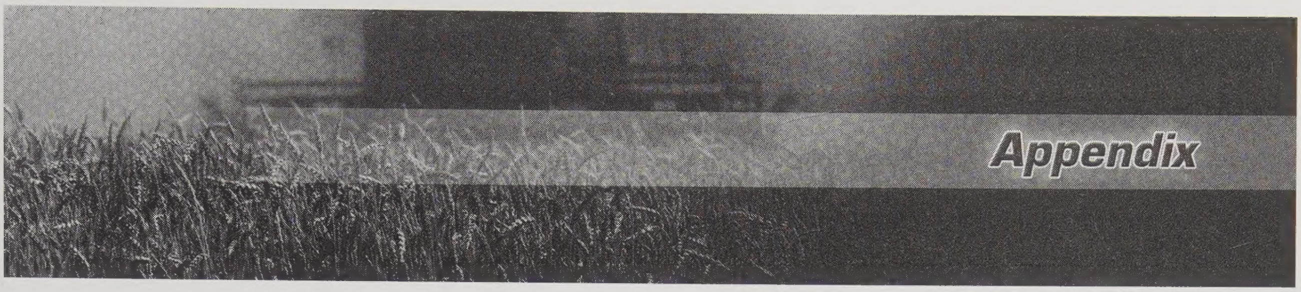
____________________ **11.** Untreated calfskin

____________________ **12.** Fruit pits

____________________ **13.** Plastic pellets

____________________ **14.** Coal

____________________ **15.** Paper products

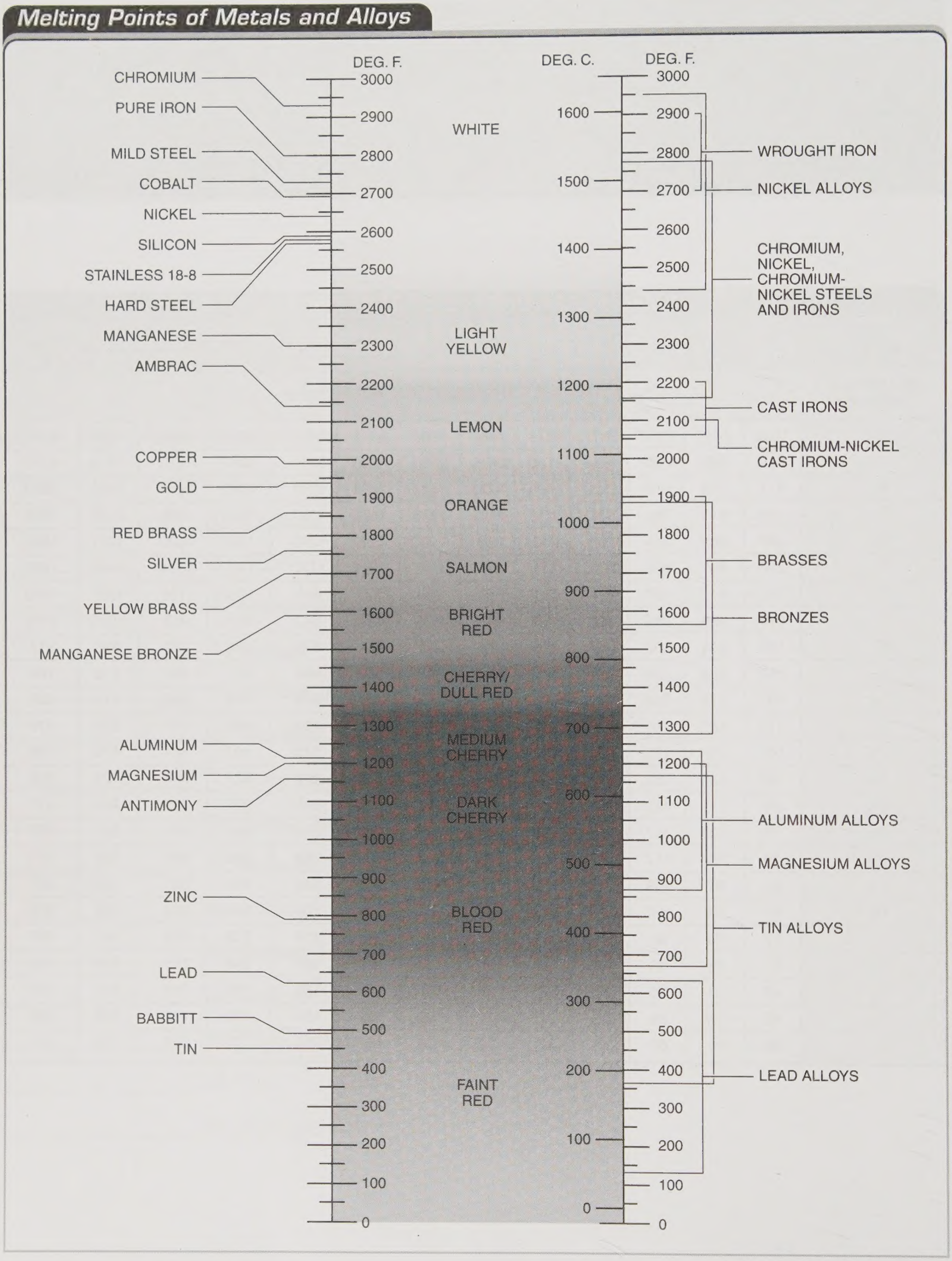


Appendix

RPM Speeds for Fraction Size Drill Bits

FEET PER MIN	30	40	50	60	70	80	90	100	110	120	130	140	150
DIAMETER (INCHES)	**REVOLUTIONS PER MINUTE**												
¹⁄₁₆	1833	2445	3056	3667	4278	4889	5500	6111	6722	7334	7945	8556	9167
⅛	917	1222	1528	1833	2139	2445	2750	3056	3361	3667	3973	4278	4584
³⁄₁₆	611	815	1019	1222	1426	1630	1833	2037	2241	2445	2648	2852	3056
¼	458	611	764	917	1070	1222	1375	1528	1681	1833	1986	2139	2292
⁵⁄₁₆	367	489	611	733	856	978	1100	1222	1345	1467	1589	1711	1833
⅜	306	407	509	611	713	815	917	1019	1120	1222	1324	1426	1528
⁷⁄₁₆	262	349	437	524	611	698	786	873	960	1048	1135	1222	1310
½	229	306	382	458	535	611	688	764	840	917	993	1070	1146
⅝	183	244	306	367	428	489	550	611	672	733	794	856	917
¾	153	203	255	306	357	407	458	509	560	611	662	713	764
⅞	131	175	218	262	306	349	393	436	480	524	568	611	655
1	115	153	191	229	267	306	344	382	420	458	497	535	573
1⅛	102	136	170	204	238	272	306	340	373	407	441	475	509
1¼	92	122	153	183	214	244	275	306	336	367	397	428	458
1⅜	83	111	139	167	194	222	250	278	306	333	361	389	417
1½	76	102	127	153	178	204	229	255	280	306	331	357	382
1⅝	70	94	117	141	165	188	212	235	259	282	306	329	353
1¾	65	87	109	131	153	175	196	218	240	262	284	306	327
1⅞	61	81	102	122	143	163	183	204	224	244	265	285	306
2	57	76	95	115	134	153	172	191	210	229	248	267	287
2¼	51	68	85	102	119	136	153	170	187	204	221	238	255
2½	46	61	76	92	107	122	137	153	168	183	199	214	229
2¾	42	56	69	83	97	111	125	139	153	167	181	194	208
3	38	51	64	76	89	102	115	127	140	153	166	178	191

Melting Points of Metals and Alloys



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